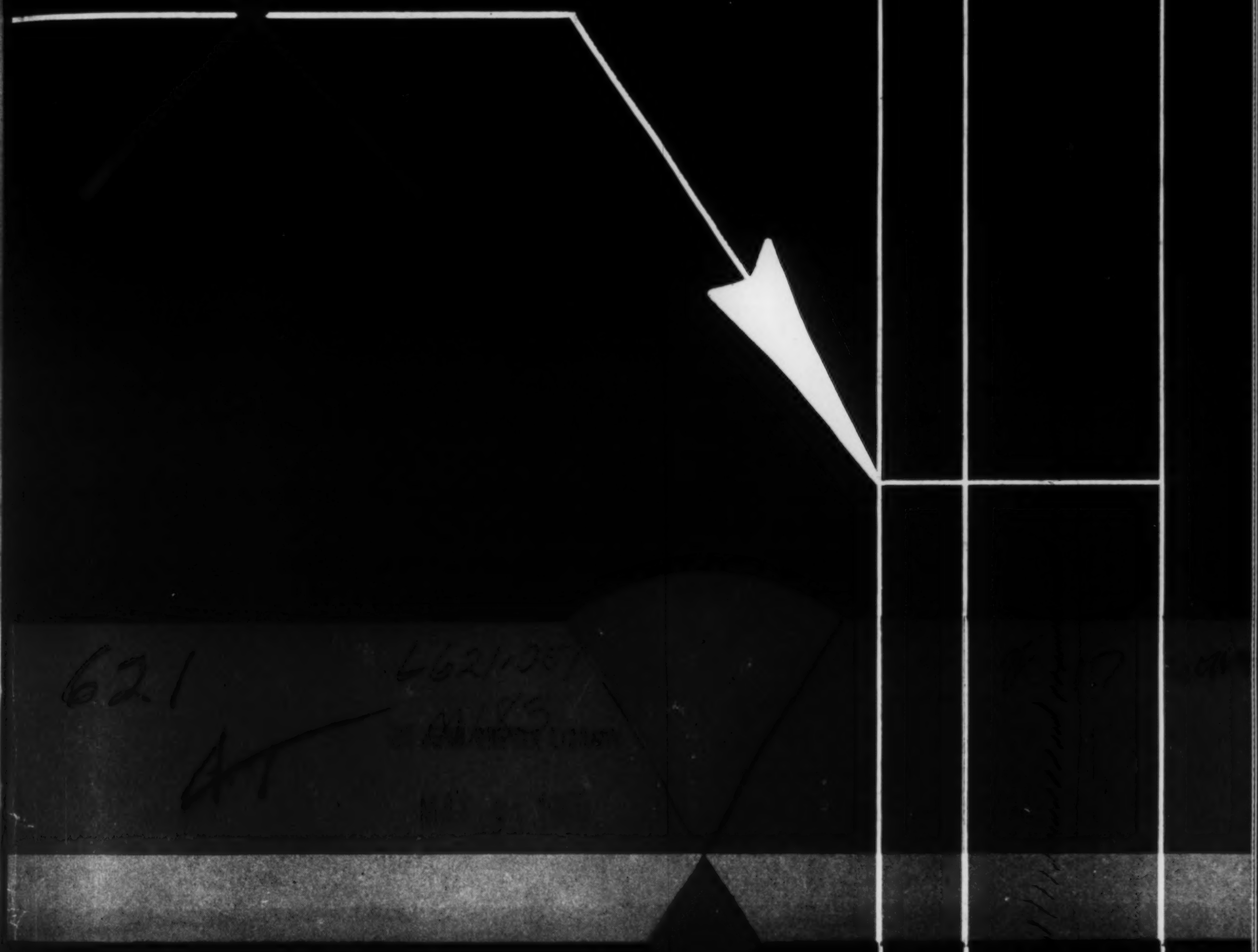
MAY 3, 1956
EVERY OTHER THURSDAY

MACHINE DESIGN

A PENTON PUBLICATION



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Welding Composite Metals

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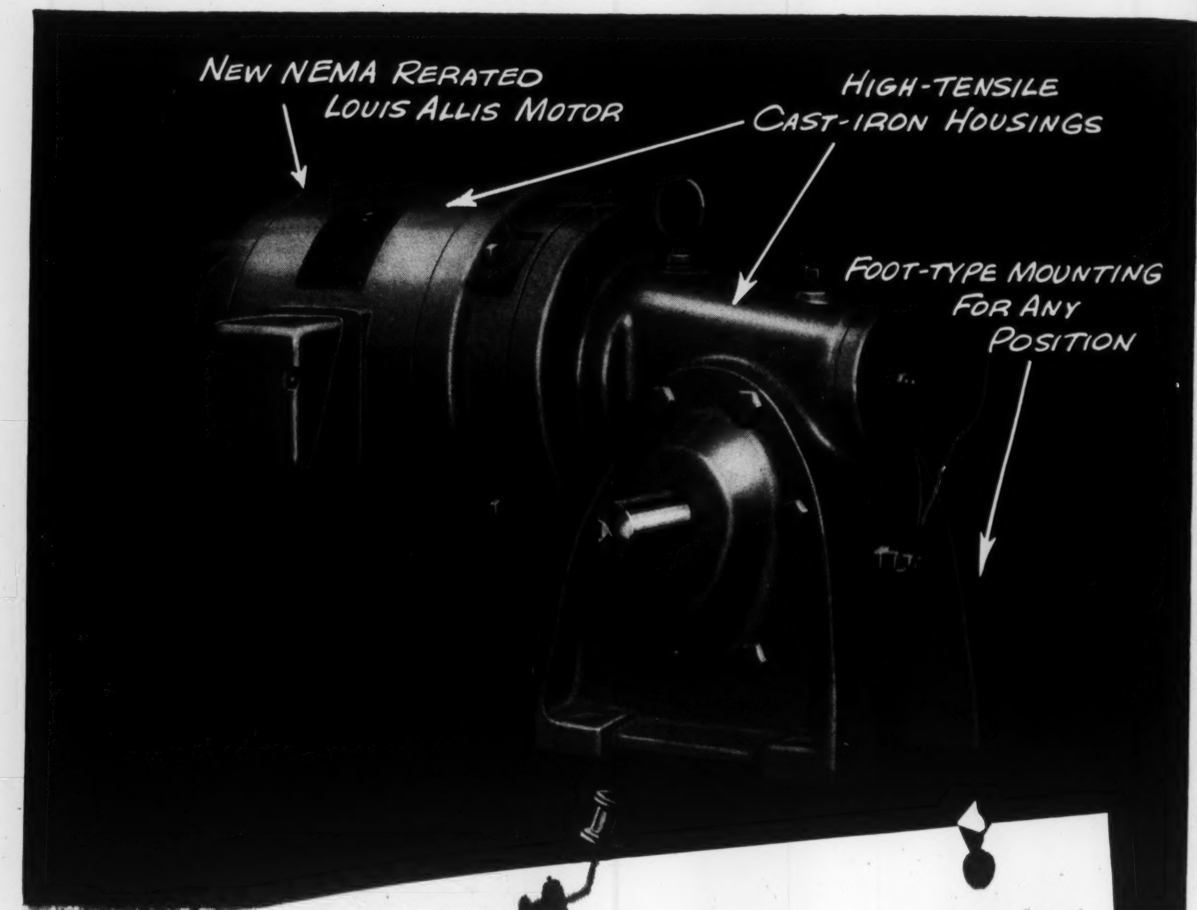
NEW NEMA RERATED LOUIS ALLIS MOTOR
HIGH-TENSILE CAST-IRON HOUSINGS
FOOT-TYPE MOUNTING FOR ANY POSITION

Louis Allis announces its L.A. line of right-angle gearmotors

Now available with new NEMA rerated L.A. motors for all applications — in sizes from 1 to 30 hp

Before we go into the many design features of this compact gearmotor, let's take a look at a few other advantages:

First of all, you can get either foot- or flange-mounted units. Secondly, you can have any motor enclosure you want. And finally, you can have any electrical or mechanical modification needed for any specific application.

In other words, here's a line of gearmotors ruggedly designed, versatile and efficient—to give you a sound answer to your right-angle gearmotor drive problems. Here's why:

- Both gear and motor housings are made of high-tensile cast iron to provide maximum strength, rigidity, and compactness.
- The worm, carefully machined from hardened alloy steel, is ground to close tolerances to give greater efficiency and longer life.
- The worm gear is cut from a high grade of wear-resistant alloy bronze.
- A double-row angular contact bearing and a ball bearing provide for radial and thrust loads on the worm shaft.
- The output shaft is mounted in tapered roller bearings for maximum load-carrying capacity.
- Ample oil-bath lubrication assures longer life and minimum maintenance.
- Special oil seals on all shafts keep the oil in -- dirt out and permit any mounting arrangement.

Here's a line of right-angle gearmotors that's very easy to apply. Standard speed range from 7-1/2 to 300 rpm-- special speeds also are available.

Flange-mounted right-angle gearmotor with new L.A. line explosion-proof motor

GM-103

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

—ITEM 551—

More than 100 Valves
from One Basic Model

Introducing the COMET II

An Advanced Conception of Valving by Ross!

- Direct solenoid operated, balanced spool 4-Way—for air or oil service.
- Engineered and built to tolerances of .0001".
- **Conforms to JIC standards.**
- Complete valve cycle within 0.033 sec.
- Made of aluminum—single solenoid, base mounted weighs only 3½ lbs.
- Working surfaces almost as hard as a diamond.
- Small and compact—7¼" by 3½" by 3⅞". ¼" diameter flow capacity.
- Available with ¼" or ⅜" pipe tap for inline, manifold or base mounted; single solenoid spring return, double solenoid momentary; double solenoid three position.

Write, wire or phone for complete information

Control

Tomorrow's Engin*AIR*ing Delivered Today . . . Anywhere

Ross OPERATING VALVE COMPANY

109 E. GOLDEN GATE AVENUE • DETROIT 3 • MICHIGAN

—ITEM 554—

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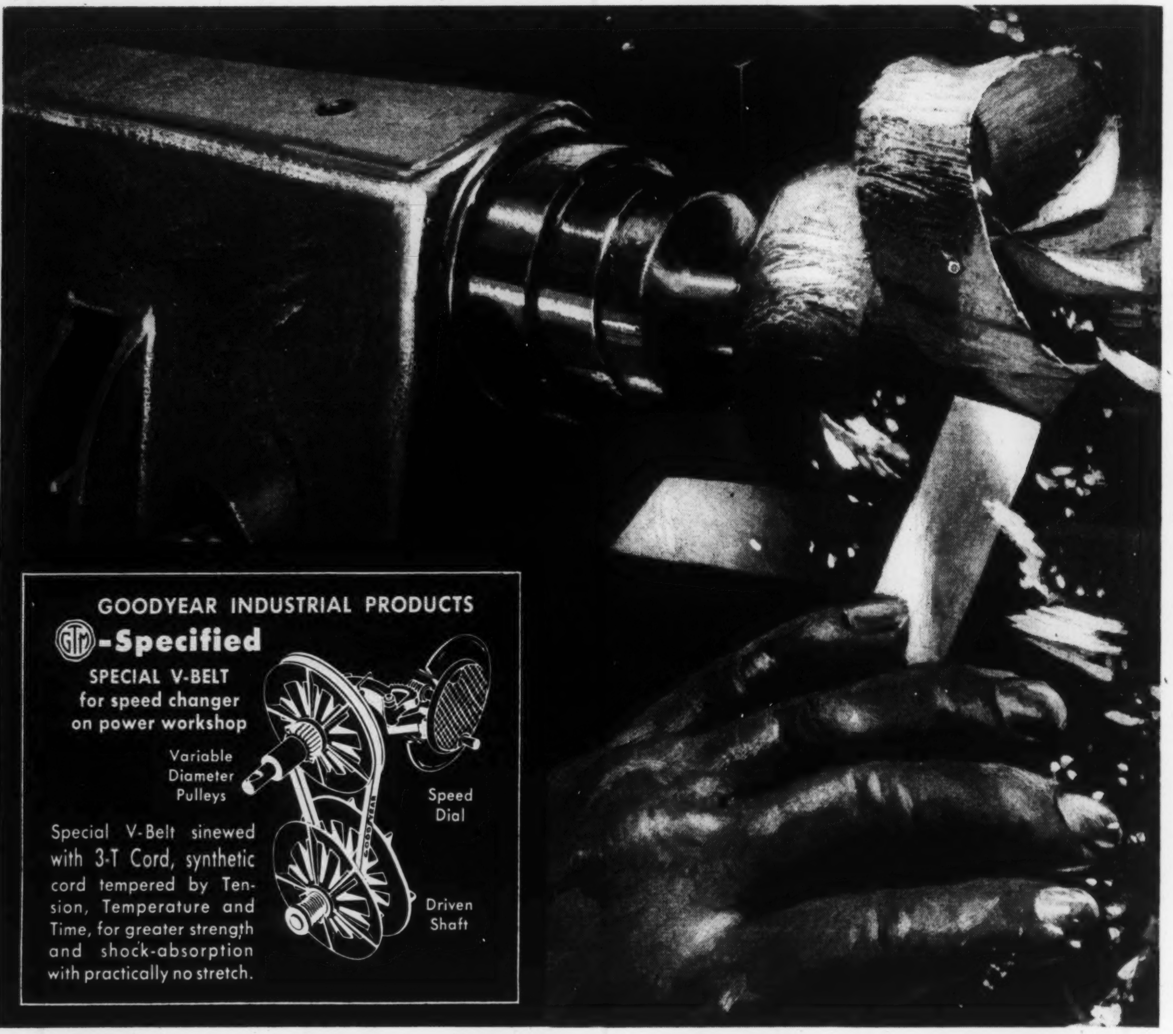

GOODYEAR INDUSTRIAL PRODUCTS

GTM-Specified

SPECIAL V-BELT
for speed changer
on power workshop

Special V-Belt sinewed with 3-T Cord, synthetic cord tempered by Tension, Temperature and Time, for greater strength and shock-absorption with practically no stretch.

Secret of a New Twist in Power Workshops

A LEADING manufacturer of home workshop power tools wanted to make speed changing in an all-new model easy and convenient. Dialing the operation on a speed-dial was the answer. A simple twist of the dial and the operator could have the right speed. The various speeds could be obtained by changing the distance between halves of split pulleys. This would vary the diameter of the pulleys and the resultant r.p.m. But how to get a belt that could withstand the constant changing in diameter and not stretch was the problem.

The G.T.M. – Goodyear Technical Man – was called on for help. He worked with the problem for a year during the planning and developing stages, finally delivered a special, precision-built V-Belt – sinewed with Triple-Tempered (3-T) Cord. This super belt not only outperformed competitive belts by withstanding *four times as many stalls* at 2500 r.p.m., but also ran much quieter and smoother – completely solving the problem.

How can the G.T.M. help solve your V-Belt problem? You can consult him through your Goodyear Distributor or Goodyear, Industrial Products Division, Akron 16, Ohio.

IT'S SMART TO DO BUSINESS *with your Goodyear Distributor. He can give you fast, dependable service on Hose, V-Belts, Flat Belts and many other industrial rubber and nonrubber supplies. Look for him in the Yellow Pages under "Rubber Goods" or "Rubber Products."*

V-BELTS with TRIPLE-TEMPERED (3-T) CORD by

GOODYEAR

THE GREATEST NAME IN RUBBER

—ITEM 555—

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THE PROFESSIONAL JOURNAL
FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

May 3, 1956
Volume 28—No. 9

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Machine Design is sent at no cost to management, design and engineering personnel whose work involves design engineering of machines, appliances, electrical and mechanical equipment, in U. S. and Canadian companies *employing 20 or more people.* Copies are sent on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U. S. government installations performing design engineering of products are also eligible.

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When requesting changes of address, etc., please allow four to six weeks for processing.

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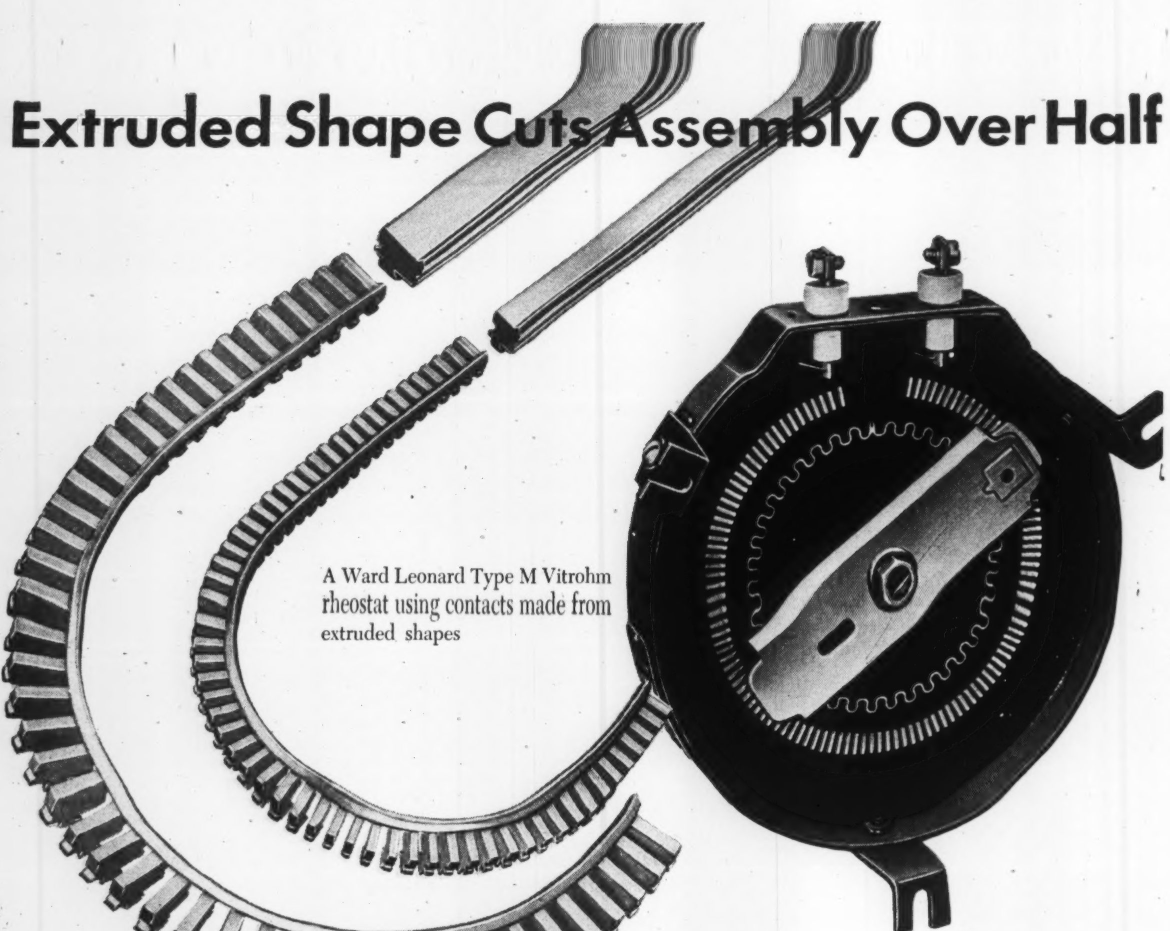
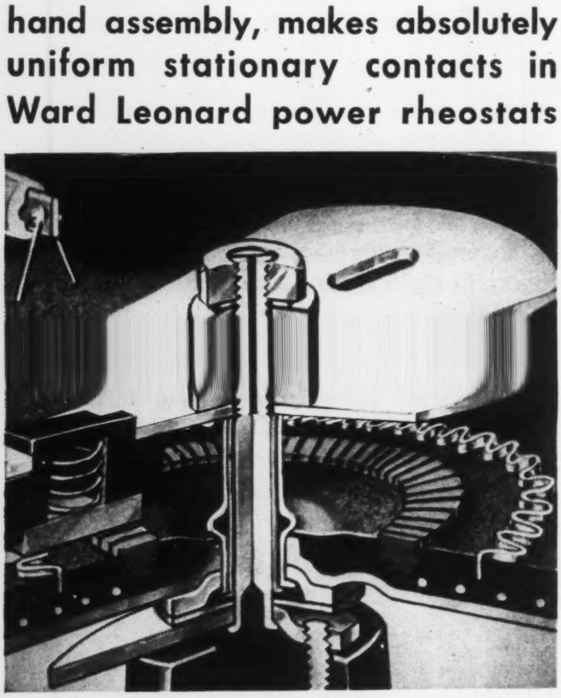
Extruded Shape Cuts Assembly Over Half



A Ward Leonard Type M Vitrohm rheostat using contacts made from extruded shapes

Ingenious application eliminates hand assembly, makes absolutely uniform stationary contacts in Ward Leonard power rheostats



CROSS SECTION VIEW of a Ward Leonard Vitrohm Type S rheostat showing how contacts are embedded in a vitreous enamel.

Ward Leonard Electric Co., Mount Vernon, N. Y., makes a line of high quality power rheostats marketed under the trade-name Vitrohm. Anywhere from 41 to 161 individual stationary contacts, or buttons, have to be embedded with their resistance elements in an insulating vitreous enamel—all contacts uniformly set and spaced, for uniform performance. Their patented process originally used buttons blanked out of sheet brass—hand assembled and spaced on a steel wire to hold them while the vitreous enamel was fired.

Ward Leonard refined the process and for four models now starts with the extruded shapes shown above. The stock is accurately slotted for correct spacing, forming a continuous line of buttons connected by a triangular "wire"—which is an integral part of the extruded shape. When sections are curved, the buttons remain uniformly spaced and oriented. After the button assemblies are embedded in the vitreous enamel, the connecting wire is easily milled off. Ward Leonard gets absolute uniformity with less effort and fewer rejects—it gets healthy dollar savings, despite the fact that more than half of the extruded shape is milled out.

Imagination applied to extruded shapes can pay big dividends—lower direct labor costs—fewer machining operations—less scrap—improved product quality. Your Anaconda representative will be glad to work with you. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5584

ANACONDA®

EXTRUDED SHAPES

Short cuts to a finished product

—ITEM 556—

For More Information Circle Item Number on Yellow Card—page 19

Engineering News Roundup

Photocopy Method Used For Printed Circuits

Process Prints Powder Patterns

ROCHESTER, N. Y.—A photocopy process used in office duplicating equipment has been adapted to the preparation of printed electrical circuits. The Haloid Co. demonstrated that xerography can be employed for model shop work, prototype circuit studies and short production runs.

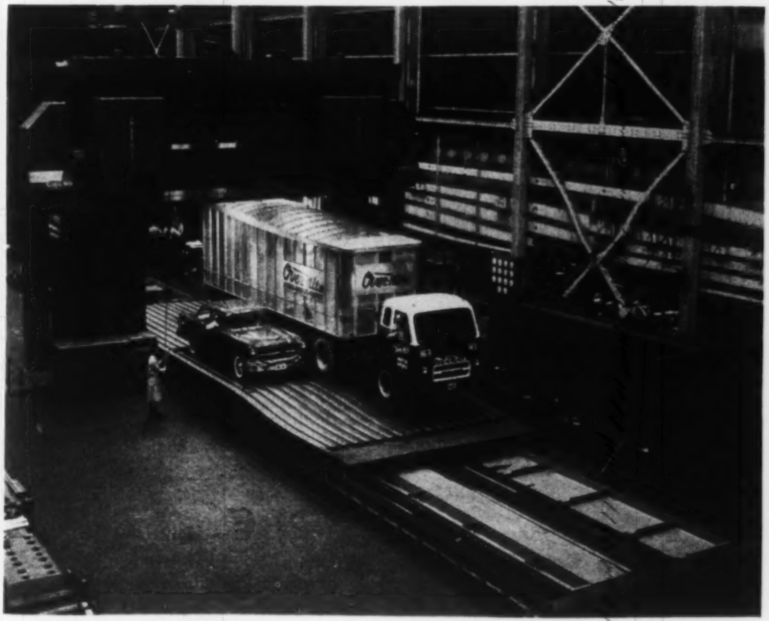
In the xerographic process, a powder image is transferred from a selenium plate to a sheet of transfer paper, thence to the face of a copper-clad laminate. Here the powder forms a resist pattern impervious to chemical attack.

In the etching step which follows, acid eats away all the copper unprotected by resist. The result is metal left only where specified by the original circuit drawing. The xerographic powder or resist, having accomplished its purpose, is then removed by solvent, disclosing the completed print ready for dip-soldering to "pig tails" or other contacts.

From an original opaque drawing, a copper-clad laminate serving as a printed circuit or wiring board can be prepared for etching in about 10 minutes. Except for the final etching step, the xerographic approach is entirely dry, requiring neither conventional photographic materials nor darkroom facilities.

Usually, printed circuits are small enough that several identical circuits may be made in one exposure. The number possible from one cycle depends on the size of the circuit and the sensitive area of the selenium plate.

Haloid claims savings in time and the cost of materials over other methods of doing the same work in the same volume.



BIGGEST MILLING MACHINE has been developed by Ingersoll Milling Machine Co. for the G-E steam turbine-generator plant in Schenectady. This set-up illustrates its size: 120 ft long, 35 ft high, 42 ft wide. It can machine pieces 18 ft wide, 16½ ft high. Two work tables allow setting up or unloading one work piece while another is being milled

Program Details Set for Mechanisms Conference

Authorities to Discuss New Design Developments

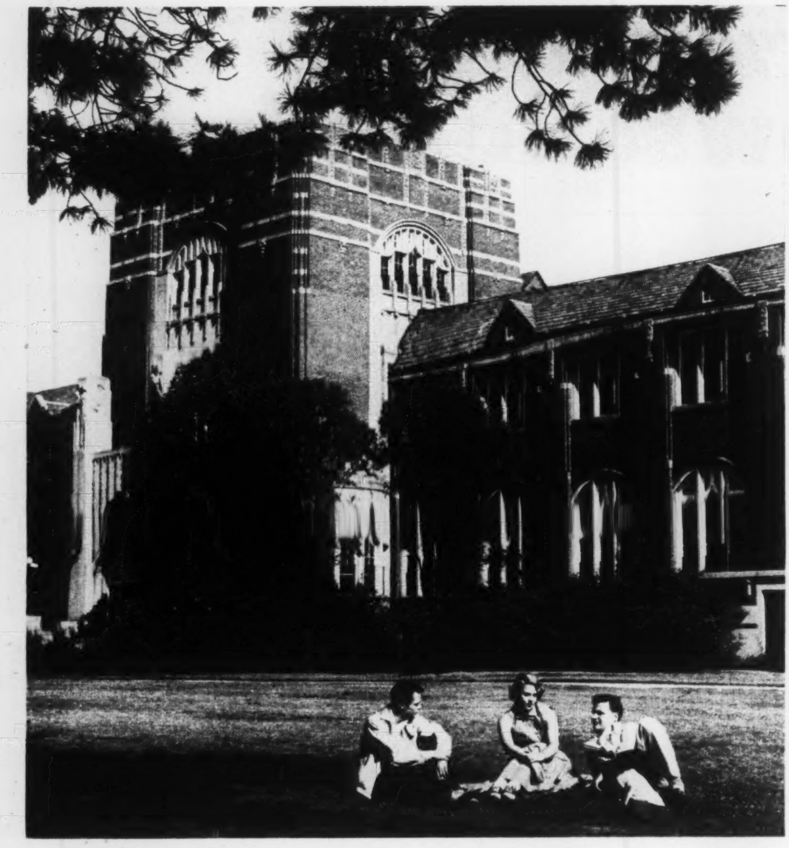
CLEVELAND, O.—Final details have been arranged for the program of the Third Mechanisms Conference to be held at Purdue University on May 24 and 25. The conference is sponsored jointly by the university's School of Mechanical Engineering and MACHINE DESIGN. Two previous conferences held at Purdue in 1953 and 1954 had been well attended and highly successful.

Believed to be the only organized meeting of its kind, the Mechanisms Conference is devoted to methods and systems for the design and development of mechanisms; practical applications and uses of cams, linkages and gearing; and production considerations and limitations.

Registration for the Third Conference is scheduled for 9 a.m. (Central Daylight time) in the South Ballroom, Memorial Union Building, on the Purdue Campus, Lafayette, Ind. Conference members will be welcomed at 10 a.m. by Prof. H. Solberg of Purdue and Colin Carmichael, editor of MACHINE DESIGN. Program for the technical sessions is:

Thursday, May 24

Session I—*Kinematic Synthesis,* 10:30 a.m. Chairman: Prof. H. G. Laughlin, Purdue Univ. Subject: *What Syn-*



Memorial Union building is a landmark on the campus of Purdue University where the Third Conference on Mechanisms will be held May 24 and 25, sponsored by the School of Mechanical Engineering and *Machine Design*

thesis Is All About, by Prof. R. S. Hartenburg and J. Denavit, Northwestern Univ.

Session II—*Intermittent-Motion Mechanisms,* 1:30 p.m. Chairman: Prof. C. L. Brown, Purdue Univ. Subjects: *Survey of Intermittent Mechanisms,* by Prof. F. J. Bogardus, Purdue Univ. and *Design of Modified Starwheels,* by K. E. Kist, Harris-Seybold Co.

Panel discussions, 3:30 p.m. Conference members may attend either *Intermittent-Motion Problems,* Prof. F. J. Bogardus, Purdue Univ., chairman, or *Mechanism Selection and Design Problems,* Prof. A. S. Hall, Jr., Purdue Univ., chairman.

Banquet, 6:30 p.m., in North Ballroom, Memorial Union Building. Toastmaster is Prof. A. S. Hall, Jr. Following dinner, Prof. R. S. Hartenberg of Northwestern Univ. will discuss *Mechanisms Abroad*—an informal observation of current European developments.

Friday, May 25

Session III—*Practical Approaches to Cam Design,* 8:30 a.m., South Ballroom. Chairman: Prof. A. R. Holowenko, Purdue Univ. Subjects: *Basic Factors in Cam Design,* by Prof. H. Rothbart, City College of New York, and *Cam Design and Production Procedures,* by W. D. Cram, United Shoe Machinery Corp.

Panel discussions, 10:15 a.m. Conference members may attend either *Cam Design Problems,* Prof. H. Rothbart, chairman, or *Dimension Problems,* E. T. Fortini, Datamatic Corp., chairman.

Luncheon, 12:00 p.m., in North Ballroom, Memorial Union Building. Toastmaster is B. L. Hummel, associate managing editor, MACHINE DESIGN.

Group discussions, 1:30 p.m. Groups will be organized to provide opportunity for designers and engineers of similar machine or product types to exchange discussion on common problems. Conference members will also be invited to present any points of view or solutions to problems they have developed in any of the subject areas covered by the discussions.

An advance registration form for the Conference appears on Page 229, April 19 issue. Or, for complete information, write to Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

Nondestructive Unit Tests Adhesive Bonds in Aircraft

Expect Device to Increase Sandwich Type Construction

CLIFTON, N. J.—A new tester, developed by Stanford Research Institute and manufactured by Allen B. du Mont Laboratories Inc., will enable airframe, missile and helicopter manufacturers to test the strength of adhesive bond material without destruction of the unit under test.

The Ultrasonic Bond Analyzer consists of a sweeping oscillator, a barium-titanate transducer, a cathode-ray oscillograph and an oscillograph record camera. The crystal transducer applies ultrasonic stresses to the piece under test. Through a method of coupling signals to and from the metal, the instrument receives responses which appear on the oscillograph in wave form. Flaws in the laminate can be identified by reading the oscillograph patterns.

Lack of a nondestructive tester for checking adhesive bonds has heretofore limited the use of laminated and skin-honeycomb-skin metal sandwiches in airframe construction, according to Du Mont. This type of construction, desirable in aircraft because of its heat resistance and strength, is being used in conjunction with laminated metals in helicopter blades and in some aircraft and missiles.

Entries are being accepted for the sixth annual Design Award Program sponsored by the Industrial Designers' Institute. Purpose of the program is to recognize industrial designers for "noteworthy and fresh approach to design and function, combined with

Front Cover

The first article of a two-part series by Helmut Thielsch on welding composite metals provides the theme for this issue's cover by artist George Farnsworth. Clad metals are the subject of the first article. A second article on applied liners will appear at a later date.

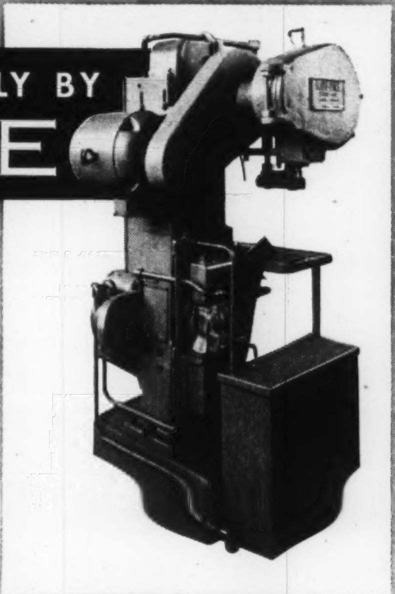
OILGEAR "JK" FEED PUMPS

USED EXTENSIVELY BY MOLINE

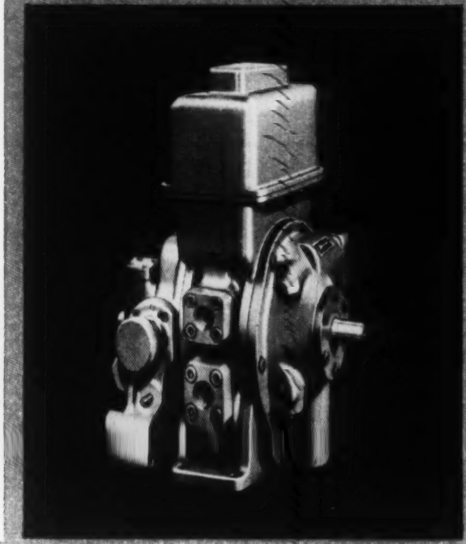
The Moline Tool Company, long established and respected in industry, has used Oilgear Fluid Power Feeds since 1925. Of Oilgear "JK" Fluid Power Feed Pumps used in its machines, Moline says these pumps *combine* the advantages found only in part in various mechanical feeds. Also, the "JK" Feed Pump provides infinitely, steplessly variable speeds; you can easily find the speed best suited to the work or condition of tools. Traverse speed can be as much as 265 times the feed rate. Coarse and fine feed rates are variable over a 20 : 1 range. Cycle time is cut drastically, production increased, costs reduced. Feed rates are maintained accurately despite varying work pressures by a built-in automatic pressure compensator.

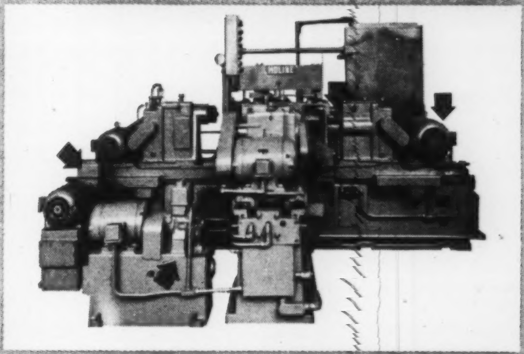
"JK" Feed Pumps are simple, compact, electro-hydraulically controlled units, easily installed nearby or remotely. Systems need only a pump with reservoir, a double-acting cylinder, standard control and two easily connected pipes. Eliminating expensive engineering, these units can simplify design, reduce manufacturing cost, improve performance and increase saleability of machines. Manual, semi-automatic or full automatic operation. Available now in 4 sizes. Write for free literature.

THE OILGEAR COMPANY
1568 West Pierce Street
Milwaukee 4, Wis.



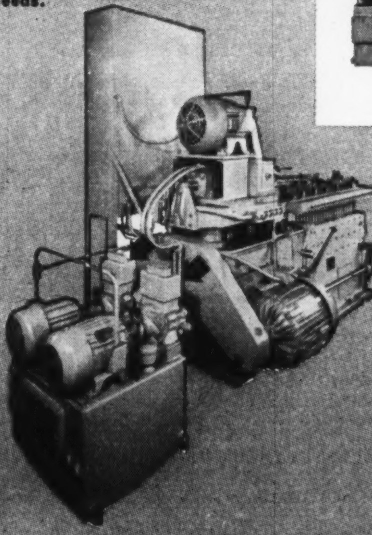
Above, Moline Drilling Machine employing "JK" Feed Pump.



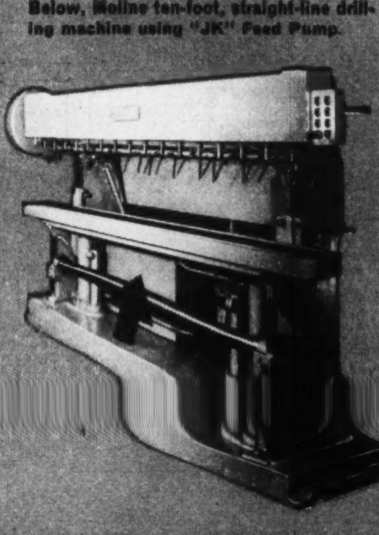


Moline 4-way horizontal boring machine uses 4 Oilgear "JK" Feed Pumps.

Below, Moline special 56-spindle back-spotfacing machine using 2 "JK" units for vertical and horizontal feeds.



Below, Moline ten-foot, straight-line drilling machine using "JK" Feed Pump.



"JK" PUMPS EASILY APPLICABLE TO YOUR MACHINES FOR BETTER PERFORMANCE

JIC

PIONEERS . . . NOW THREE PLANTS FOR FLUID POWER

OILGEAR
Fluid Power

PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

practical use of appropriate materials."

Any designer, or team of designers, in the industrial design field is eligible to compete. Details of the program are contained in the submission forms, which are available from Walter C. Granville, chairman of the program, at Container Corp. of America, 38 S. Dearborn St., Chicago 3, Ill. Forms must be postmarked by May 19.

Topics

All-around glasses, recently patented, enable the wearer to see where he's been. Extending the field of vision to 360 degrees, the spectacles are equipped with small rear-view mirrors attached to the lenses by means of adjustable arms.

• • •

Lockheed will conduct aircraft nuclear research in new laboratories to be built on a four-square-mile site near Dawsonville, Ga.

• • •

Seeing ourselves as others see us will be possible with a new British-made mirror. It is made of two wings of mirror glass, set at angles to each other, and reflects a natural image instead of the usual reversed one.

• • •

A bill to permit extension of certain expired patents is now in the Senate. It applies to inventors who were in military service when the patent expired and were unable to apply for an extension.

• • •

Rain-repellent coating keeps cockpit windshields clear in airplanes operating at speeds that make the use of mechanical wipers impractical. The coating is composed mainly of silicones and waxes. One application lasts for several days of heavy rain.

Convention Hall, Philadelphia, is the site of the First Design Engineering Show and Conference, May 14 to 17. Nearly 200 companies will exhibit products and services useful to design engineers. Concurrent with the show, a four-session conference on subjects of primary importance to designers has been arranged by the Machine Design Div. of ASME

Design Show and Conference Plans Completed

Full House of Companies to Display Products, Services

PHILADELPHIA, PA.—Final arrangements are now in process for this country's First Design Engineering Show and Conference scheduled in Convention Hall, Philadelphia, May 14 to 17. The building's main and lower arenas will be filled with displays of products and services essential to the design function in industry. Scope of the displays is indicated by the list of exhibitors.

Concurrent with the show, and at the same location, the ASME Machine Design Div. will conduct four technical sessions covering important aspects of the design function. Following are the speakers and chairmen of the four technical sessions:

Monday, May 14

Session I—*Value Analysis in Product Design.* Speakers: A. D. Bentley and W. L. Healy, both of General Electric Co. Chairman: Victor Sepavich, Crompton and Knowles Loom Works.

Tuesday, May 15

Session II—*How to Get and Train Design Engineers.* A panel discussion by: Prof. Chester Linsky, Pennsylvania State University; A. A. Johnson, Westinghouse Electric Corp.; and Dr. Bernard J. Covner, Dunlap & Associates. Chairman: Philip R. Marvin, American Viscose Corp.

Wednesday, May 16

Session III—*Selecting Engineering Materials for Products.* Speaker: W. A. Irvine, Maytag Co. *Problems in Miniaturization.* Speaker: William C. Schmidt, Bell Telephone Laboratories. Chairman: Clifford Eddison, Radio Corp. of America.

Thursday, May 17

Session IV—*Recognition and Reward for Invention.* Speaker: W. A. Steiger, Westinghouse Electric Corp. *Rights of the Employees' Inventions.* Speaker: George V. Woodling, patent attorney. Chairman: Donald G. Fink, Philco Corp.

Conference registrations will be accepted in Convention Hall at the start of the four-day sessions. Further information on the conference can be obtained from American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

Visitors to the show are cordially invited to booth 425 to meet the editors of MACHINE DESIGN and other Penton publications.

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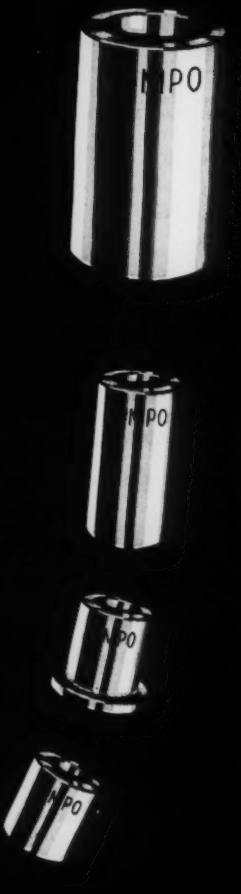

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Display Latest Products and Services at Show

First Design Show Exhibitors Listed

Companies exhibiting their products May 14-17 at the First Design Engineering Show and Conference are listed here. Floor plans of Philadelphia's Convention Hall show location of each booth.

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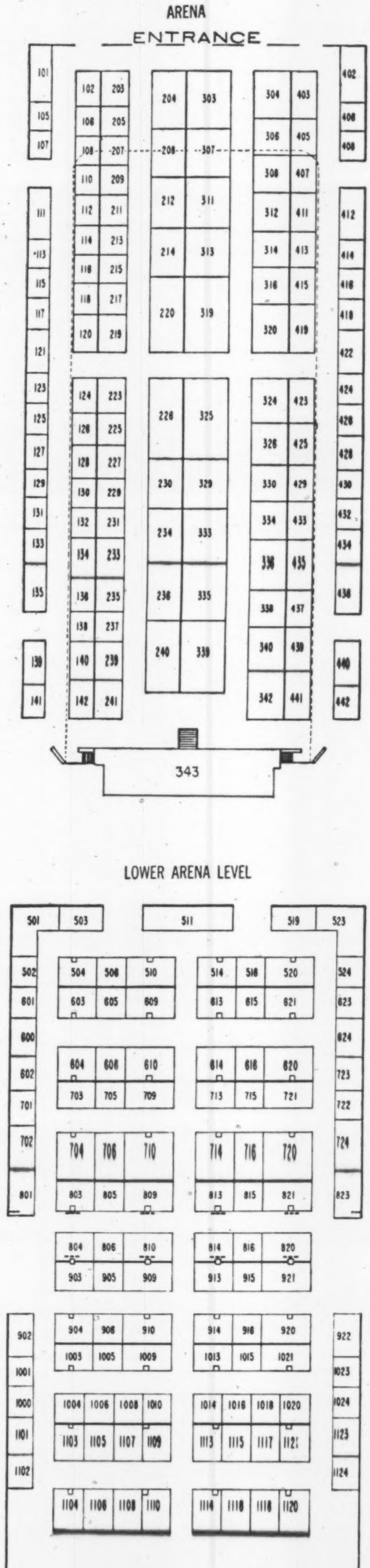
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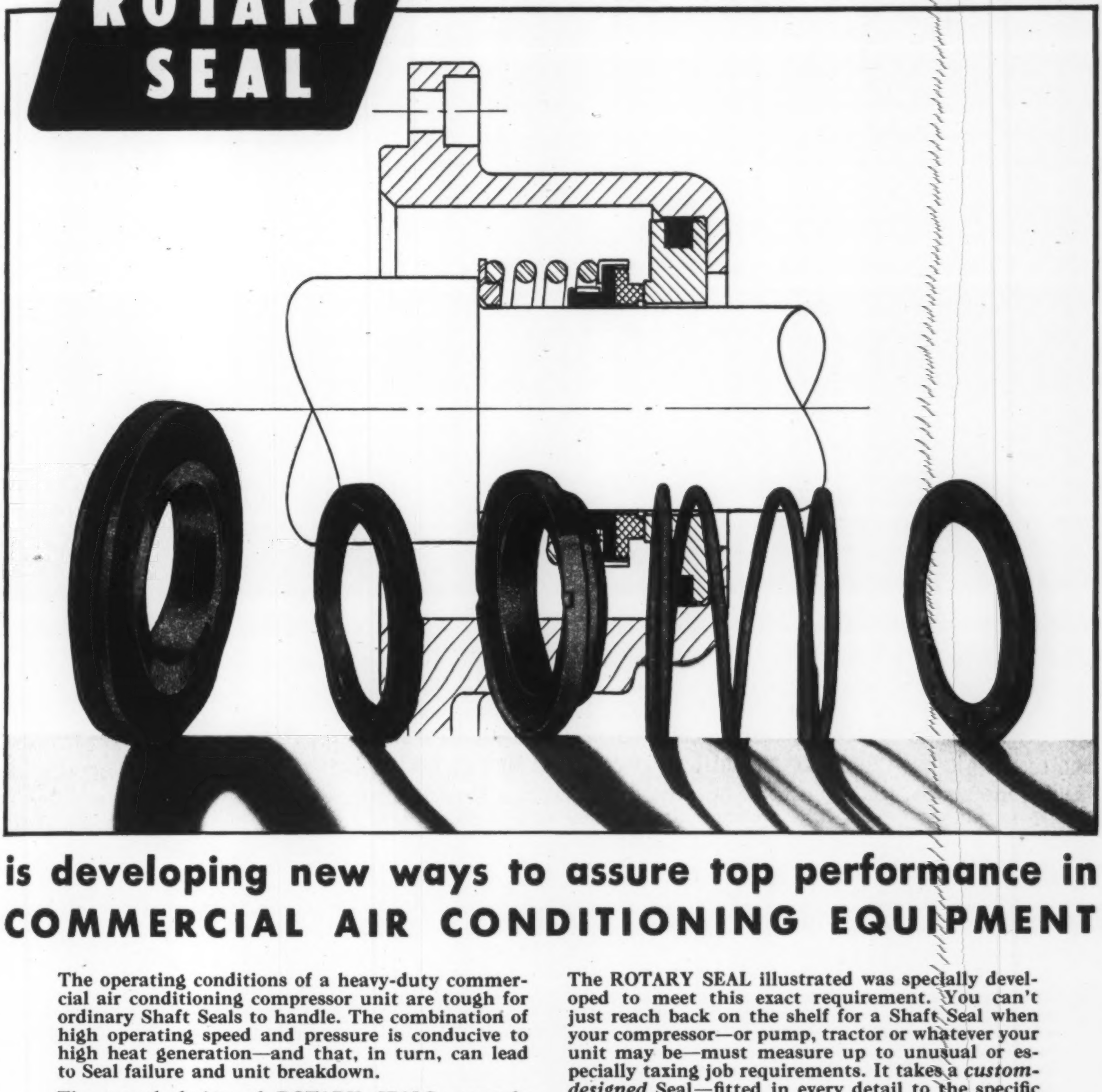
ROTARY SEAL

SPECIALIZED SEAL ENGINEERING



is developing new ways to assure top performance in COMMERCIAL AIR CONDITIONING EQUIPMENT

The operating conditions of a heavy-duty commercial air conditioning compressor unit are tough for ordinary Shaft Seals to handle. The combination of high operating speed and pressure is conducive to high heat generation—and that, in turn, can lead to Seal failure and unit breakdown.

The sound design of ROTARY SEALS—properly adapted to the particular conditions of this application—removes most of the major cause of such failures, without requiring complicated unit design. With this sturdy Seal, heat dissipation is excellent, and even under the severe operating conditions, heat generation is effectively reduced. Net result: greater customer satisfaction, elimination of trouble and expense through constant service calls.

The ROTARY SEAL illustrated was specially developed to meet this exact requirement. You can't just reach back on the shelf for a Shaft Seal when your compressor—or pump, tractor or whatever your unit may be—must measure up to unusual or especially taxing job requirements. It takes a *custom-designed* Seal—fitted in every detail to the specific job at hand.

ROTARY SEAL specializes in developing and manufacturing Seals to meet such problems, by applying the basic ROTARY SEAL principles which opened the way to successful mechanical Shaft Sealing when this company introduced them years ago.

Major assignments for important Seal developments are keeping us mighty busy at present; but if special difficulties are besetting your development programs, and production quantities of Seals are involved, we'll be glad to help if we can.

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MUSKEGON
PISTON RING CO.

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Shaft-Sealing with Certainty

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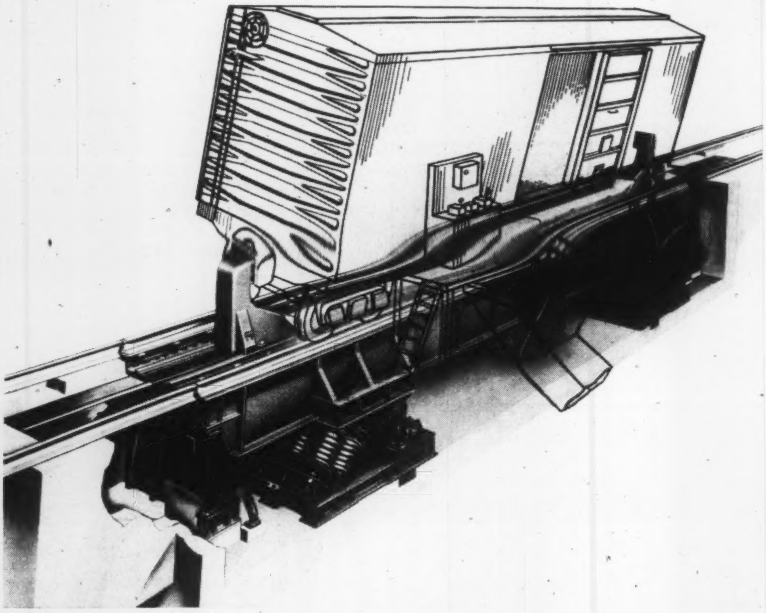

ROCK AND RAIL COMBO hits the right note in speedy boxcar unloading. This new Link-Belt unloader uses oscillating motion and slight elevation of one of a pair of railroad tracks to produce the motion and tilt necessary to empty bulk material at the rate of four loads per hour. Standard railroad cars weighing up to 150,000 lb loaded are locked in place in the Kar-Flo unit and rocked gently up to a maximum of 3 in. at each end. Most of the unloading mechanism, including the 25-hp main drive motor, is located in a 7 ft, 3 in. pit. At ground level are the rails, mounted on a platform next to the load-receiving hopper, and an operator's control station

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New Standard For Military Name-Calling

Services Adopt Civil Phonetic Alphabet

WASHINGTON, D. C.—Old salts and old soldiers long accustomed to *Able, Baker, Charlie* as the ABC's of phonetic communication must now learn a new alphabet. On March 1 the armed forces adopted the Civil Aviation Organization Phonetic Alphabet that goes:

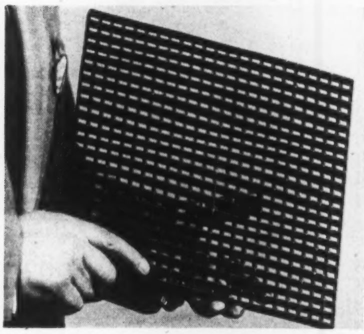
Alfa
Bravo
Charlie
Delta
Echo
Foxtrot
Golf
Hotel
India
Juliet
Kilo
Lima
Mike
November
Oscar
Papa
Quebec
Romeo
Sierra
Tango
Uniform
Victor
Whiskey
X-ray
Yankee
Zulu

It's reported, however, that *Roger* will probably still mean the many things it did before, including "yes, I understand."

Molding Process Makes Complex Plastic Grids

HAWTHORNE, CALIF.—A new three-phase transition-molding process for complex plastic parts has been developed by Northrop Aircraft. Three types of material, each with a different melting point, are used to make complex plastic resin grids.

The original mold is milled in a criss-cross pattern to required depth from a block of low melting-point alloy. The narrow, milled slots are then filled with epoxy resin. When the resin has hardened, the alloy is melted away, leaving the first or master part.



This part is then covered with an elastomeric or rubberlike substance which becomes a flexible master mold. This mold may be used repeatedly to produce as many parts as needed. Since the mold is elastic, resin parts may be removed with no regard for draft angles or undercuts.

Regulator Sobers Giddy Computers

Erratic Performance Traced To Impure Power Supply

CARLSTADT, N. J.—The problem of an intoxicating effect of impure electrical power upon electronic "brains" has been solved by the Curtiss-Wright Corp.

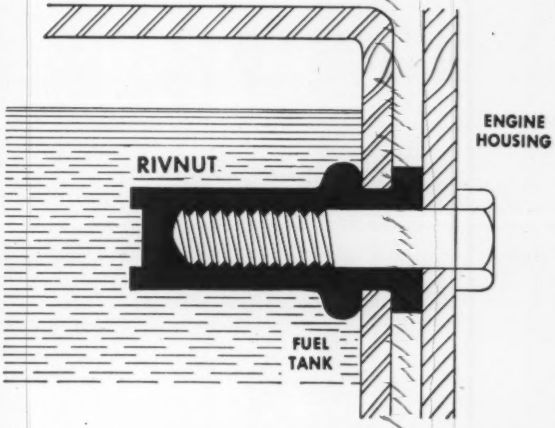
Distorted current, it seems, can make some mental robots just a little unstable at times, with a resultant loss in accuracy of computations. These distortions have remained in quantities of about 3 per cent even after the current was

B. F. Goodrich Rivnut makes nut plate and shock-proof seal in one operation

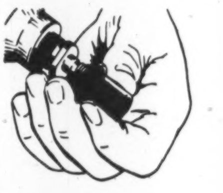
BRIGGS & STRATTON CORP. wanted to speed the assembly and streamline the appearance of a new gasoline engine without extra cost. The conventional method of attaching fuel tanks required a combination of rivets, straps, braces, nuts and bolts. Now, by using three B. F. Goodrich Rivnuts, they do the same job quicker, neater and actually at lower cost.

One man installs the Rivnuts in the gas tank wall in seconds. They provide, firm accurate nut plates that can't be loosened by shocks or vibration. At least six threads are clean for bolt attachment to the engine housing. At the same time, special closed ends make a 100% gasoline-tight seal.

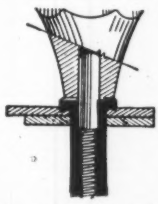
B. F. Goodrich Rivnuts are solving hundreds of fastening problems. They can probably solve yours. Write for more information or engineering help to: The B. F. Goodrich Company, Dept. MD5A, Akron, Ohio.



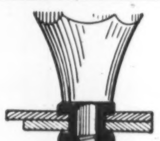
Rivnuts provide at least 6 clean threads in one simple operation!



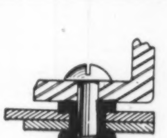
1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



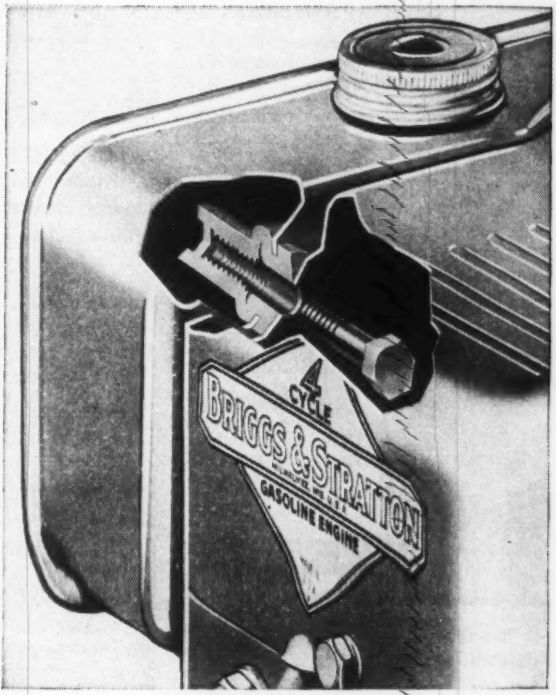
2 Rivnut is inserted—head firmly against work—tool at right angles to work.



3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.



Cutaway view of tank showing how Rivnuts make 100% gasoline-tight seal.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO and fasten WITH. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Department MD5A, Akron, Ohio.

SEE HOW RIVNUTS WORK

B.F. Goodrich

RIVNUTS

The only one-piece blind rivet with threads

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AllenAir Cylinders
AllenAir VALVES
AllenAir Spring Return Clamp AC-1x1
$5.50
AllenAir DIAL FEED TABLES
The A. K. ALLEN CO.

HAVE YOU RECEIVED YOUR COPIES OF THE NEW ALLENAIR *Catalogs?*

Shown below is only a partial grouping of new AllenAir Catalogs. These, as well as others that make up the complete AllenAir line of Air Control Equipment, are spiral bound into a handsome master catalog for your convenience and easy reference.

WRITE FOR YOUR COPY NOW!

Valve-in-Head Cylinders

Air or Electrically Operated. Selection of 8 different models to meet your specific requirements. 1⅛" to 4" bore, up to 20" stroke in STOCK.

Single & Double Ended Cylinders

Complete range of sizes; all mounting styles.

Air Valves

8 page catalog illustrating complete line of solenoid, pilot and hand valves.

Spring Return Clamp

Universal mounting, (2) ⅛ N.P.T. air inlets, 1 brass hose connector.

Dial Feed Indexing Tables

Selection of 3 different models.

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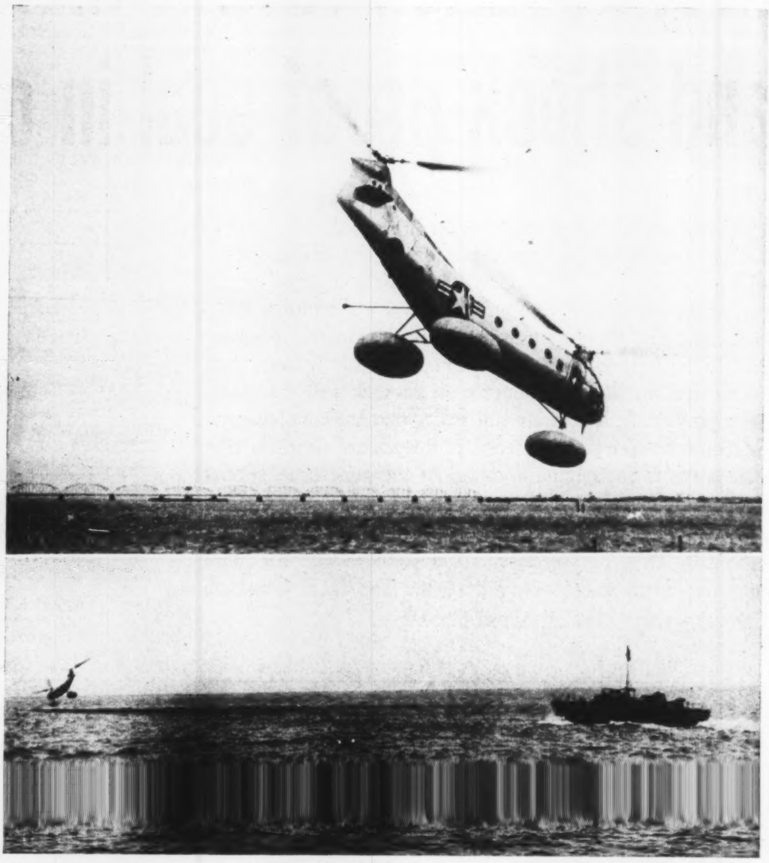
—ITEM 561—

Engineering News Roundup



A LONG HITCH IN THE NAVY has been arranged for the Piasecki H-21 helicopter. In recent tests, it has shown that it can tow mine countermeasure devices effectively and thereby remove much of the danger from the hazardous job of sweeping. The H-21 also towed an 81-ft PT boat at 11 knots in a simulated rescue at sea

treated by refining equipment.

A new distortion - eliminating voltage regulator developed by Curtiss-Wright Electronics Div. has cut this impurity factor to 0.3 per cent, permitting analog computers to function with clear heads.

The regulator supplies distortion-free 60-cycle power, functions with essentially instantaneous recovery time and faithfully reproduces the fundamental input wave form. Simultaneously, it furnishes an additional large source of regulated power for use where normal power-line distortion is acceptable.

The regulator embodies a new concept to eliminate low-frequency harmonics and noise, leaving a pure sine wave. The unique circuit taps the incoming wave form and obtains from it a sample representing all of the disturbances present. This signal is amplified and fed back into the line 180 degrees out of phase.

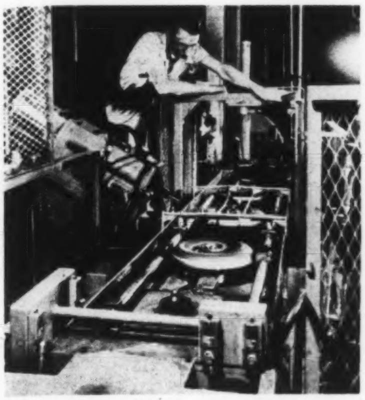
Auto Transmission Parts Balanced Automatically

Machine Inspects Its Own Work

DETROIT, MICH.—A new machine for precision balancing of Hydra-Matic transmission parts has been developed by General Motors Research Staff for the Detroit Transmission Div. Automatically, the new machine determines both the amount and location of unbalance in each of two mating torus units and corrects unbalance within ¼-oz-in.

A computer on the machine "reads" the unbalance and passes the information to a welding station. At this station a metal slug is measured, cut to size and welded to the inside rim of the torus.

The machine also checks itself. After the torus units pass the un-



balance correction station with slugs welded to rims, a balance recheck is performed. If unbalance is beyond $\frac{1}{4}$-oz-in., the parts are shifted to a "reject" conveyor. If within limits, parts are automatically stamped "accept."

Collects Data on 10,000 Radio Tubes

NBS Classifies Both Domestic and Foreign Types

WASHINGTON, D. C.—The National Bureau of Standards is making available a tube information service for accumulating and disseminating technical data on domestic and foreign radio tubes. The service includes all such data on electron tubes and semiconductor devices as electrical characteristics, bulb size and base configurations, ambient operating conditions and construction details.

By means of this service, it is possible to find (1) information about any particular tube, (2) all tube types whose electrical characteristics, bulb sizes or base configurations fall within particular ranges, and (3) domestic tubes that can be substituted for unavailable foreign tubes. Information on junction diodes and transistors is also available. Products of about 80 domestic and 15 foreign manufacturers are included.

Nearly 10,000 cards, filed by tube type number, are appropriately referenced to manufacturers' source material. About 10 per cent of the information, mainly on miniature and subminiature tubes,

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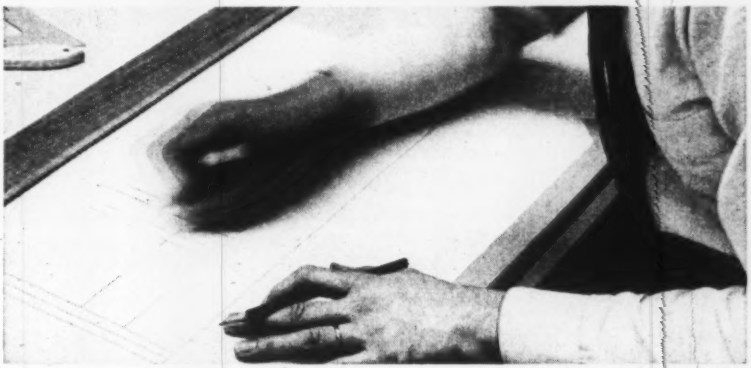
DRAFTING TRENDS



Controlled tests have proved the remarkable erasing qualities of new Blutex tracing vellum.

Improved tracing vellum erases cleaner and faster

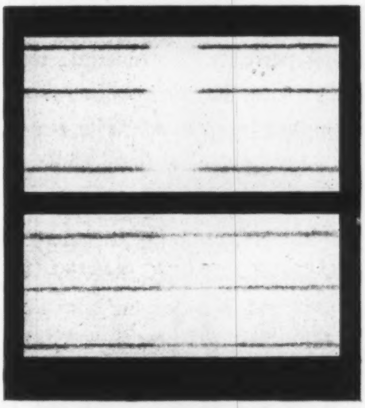
A newly improved vellum called *Blutex* has unusual erasing qualities and eliminates "ghosting" on tracings and prints. Manufactured by Post, the product is a revised formulation of an established vellum.

Chief reason for the cleaner erasing qualities is a new combination of transparentizing materials used in treating the base stock. (The base stock itself is exceptionally hard.) Unlike many other vellums, *Blutex* is treated with 100% synthetic resins rather than oils. The carefully selected resins provide a "drier" working surface; dry yet never brittle. This unusual dryness, combined with an extra hard surface, permits faster, cleaner erasures.

The new process also affects the [illegible] *future* erasability. The materials are specifically formulated to resist heat and aging. The transparentizing agents will not *fuse* with the graphite lines, a common condition in other vellums that make erasures difficult. Laboratory tests have shown that *Blutex* is just as erasable after 100 trips through a printer as it is when first used.

Another Blutex advantage is its fine *drawing* quality. The dry surface and excellent tooth take dense, opaque lines with ease and uniformity.

In addition to these improvements, new *Blutex* is actually more transparent. The new formulation is carefully controlled to preserve the stock while actually increasing the transparency.



Unretouched photos of pencil lines and erasures on Blutex (top) and another leading vellum after identical aging of both sheets.

Testing samples and information on Blutex is available from the Reader Service Division of the Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18.

POST

SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

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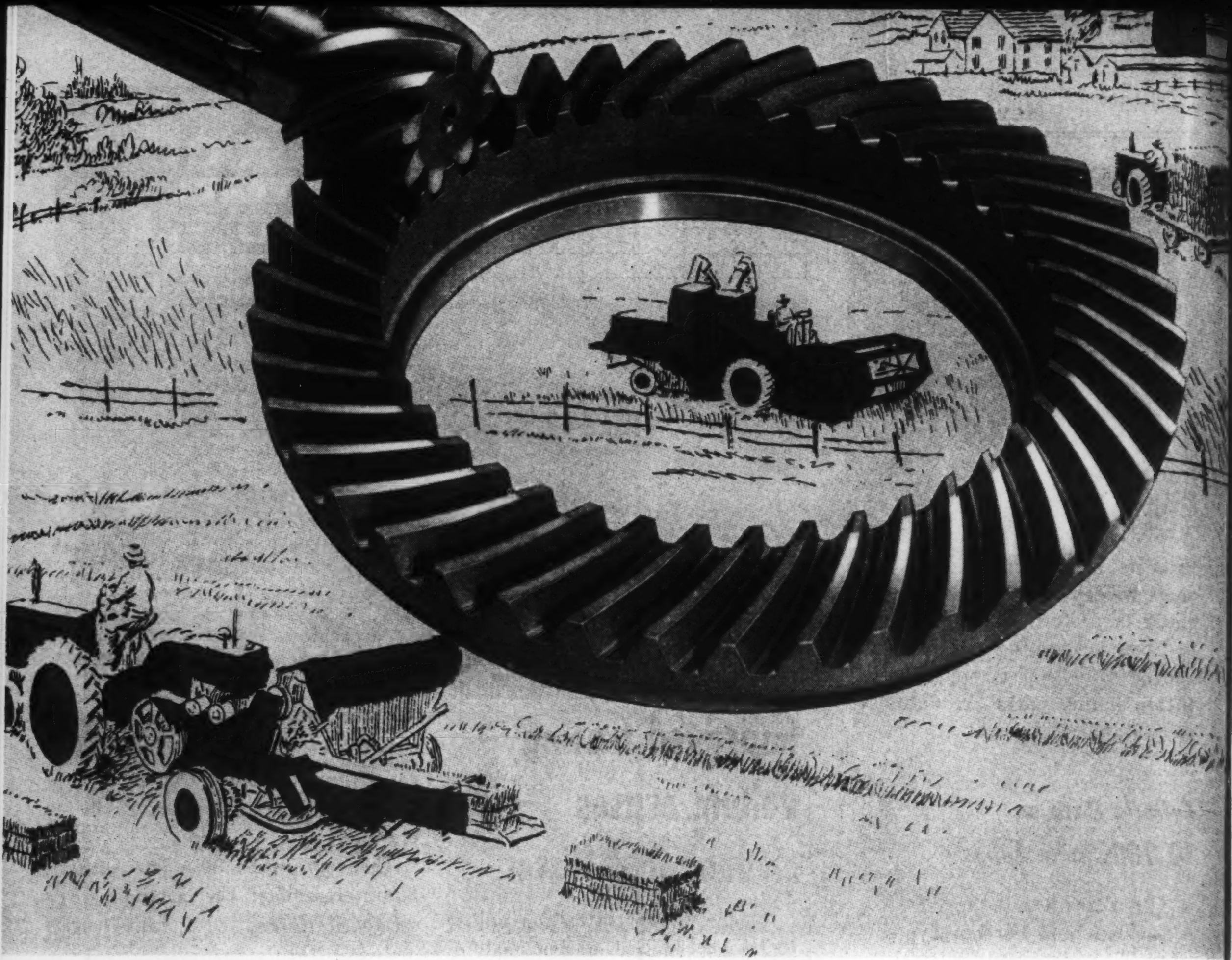

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Unlike industrial machinery, farm equipment is exposed to everything that nature can throw at it. Soil is the element in which farm machines work. They're exposed to every fury in the book—heat, cold, snow, ice, dust. They stand idle much of the time, then go to work at an instant's notice, performing perfectly for hundreds of gruelling hours. And they must be built against breakdown that interferes with the critical time schedules of much farm work.

That gears of our manufacture are specified for so many different kinds and makes of farm machinery is proof of their rugged ability to perform reliably under the most rigorous circumstances. Their daily work on America's farms proves their fitness for service in your products or equipment.

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CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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BY ITEM NUMBERS

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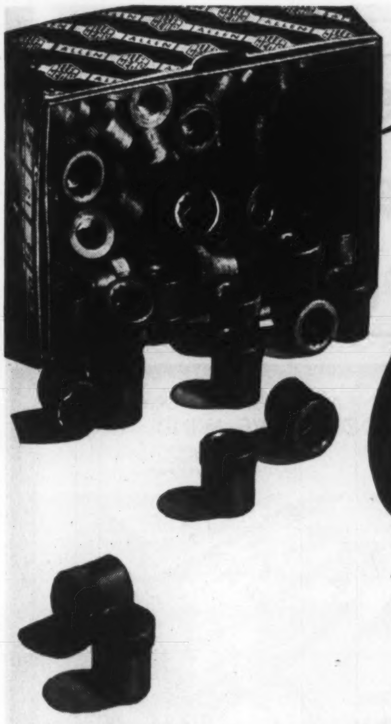

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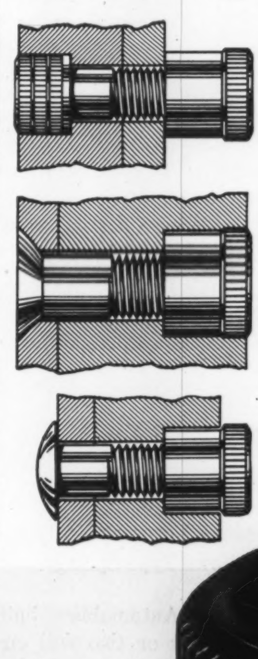

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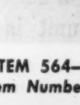

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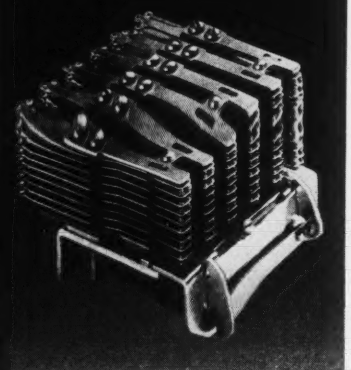

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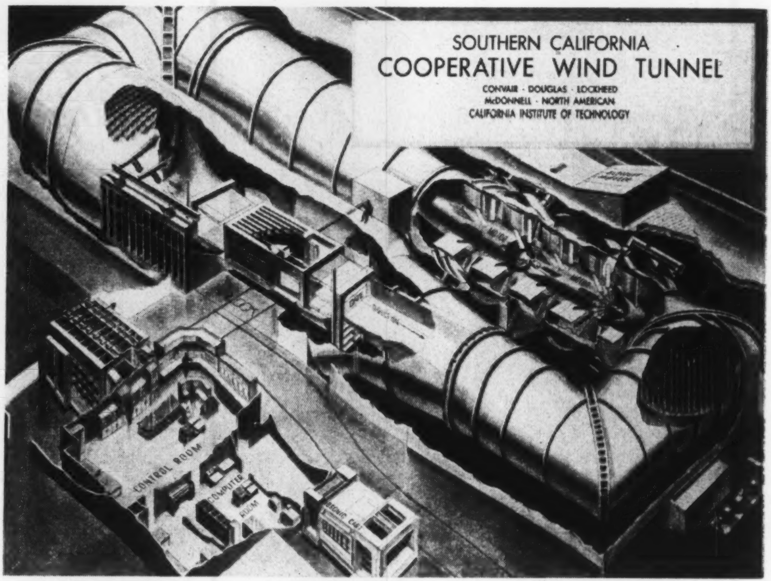
—ITEM 565—

(*Continued from Page* 15)

has been coded on punched cards for mechanical sorting. Eventually information on all tube types will be transferred to punched cards.

The tube information program was begun about seven years ago as a service to NBS personnel and has since been extended to all scientists and engineers in government and industry who have legitimate requests. It is being carried out by C. P. Marsden and J. M. Moffitt of the Bureau's electron tube laboratory.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BIG WINDS BLOW HARDER due to recent major additions to this installation operated by the California Institute of Technology and owned jointly by West Coast aircraft manufacturers. Two new 20,000-hp motors boost the top speed in the tunnel to 1400 mph. Special features of the co-op tunnel include interchangeable test sections rolled into the airlock on rails. Each section is designed for a certain range of speeds. Automatic data recorders and computers are tunnel auxiliaries

Predicts 1958 Car Buyers Will Ride on Air

Firestone Foresees Early Use Of Bellows Type Springs

AKRON, O.—Automobiles built in the next year or two will employ air-spring suspension systems similar to those now in use on busses, truck-trailers and railway passenger cars, according to Firestone Tire and Rubber Co. engineers.

Advantages claimed for the air spring system are smooth riding, low passenger and driver fatigue, quiet operation, low maintenance, long wear, and stability of car level under all loads. The springs also keep the car level in turns.

Resembling a small, smooth tire, the bellows unit is built around a drum from plies of rubber-impregnated nylon fabric. Depending on vehicle specifications, one, two or three bellows form an air spring. Two or four springs are installed on an axle and are interconnected by a system of valves and air tanks.

Show Improved Static Switch Unit

PITTSBURGH, PA.—Improved static switching components were shown at the Twentieth Machine Tool Electrification Forum held recently in Buffalo. Designated Mark II Cypak static switches, the units are similar in operation to the original Cypak controls brought out a year ago. They are 3 by 2

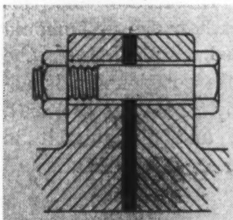
How to select gasket materials for use in basic joints

Many factors affect the choice of a gasket material. Cost, temperature involved, fluid action, flange surface characteristics, unit load or compression, and internal pressure, all must be considered. However, the first question to be answered is, "What general type of material is suitable in this particular flange?"

common flange joints

A simple flange (Fig. 1) may be sealed with nearly any kind of flat gasket, plain or jacketed. Ordinarily, however, fiber sheet, cork composition, cork-and-rubber, and similar materials are best. Straight rubber, on the other hand, tends to extrude from such a joint under medium to high flange pressures.

By reducing the gasket wall section of the simple flange (Fig. 2), a higher load is placed on the gasket without changing the bolt pressure. The flange will thus retain higher internal pressures—and gasket cost may be reduced. Again, nearly any type of flat gasket is suitable, but in this case the tendency of rubber to extrude is emphasized by the increased unit loading.



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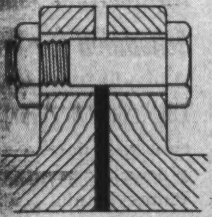

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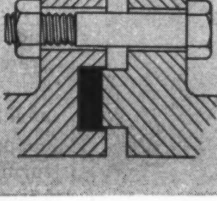
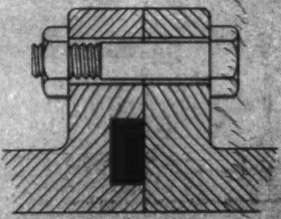


3.

A further variation of the common flange joint is the tongue-and-groove (Fig. 3), used where extremely high pressures on the gasket are needed to retain high internal pressures. It, too, may be sealed by nearly any type of flat gasket. Here, the incompressibility of straight rubber is not a problem because the gasket is completely confined. Since rubber will deform but not compress, however, a rubber gasket should be cut so that it does not fill the channel and prevent the tongue from entering the groove.

metal-to-metal joints

In metal-to-metal joints (Figures 4 and 5), rectangular-section rubber gaskets may be used effectively if their volumes and shapes are correct. That is, gasket volume cannot exceed the volume of the cavity or the joint will not close. At the same time, the shape of the gasket must permit about 25 per cent deflection of the gasket when the joint is closed. When very close gasket tolerances are impractical, the gasket can be cut larger than the cavity if relief for sideflow is provided in the joint design.



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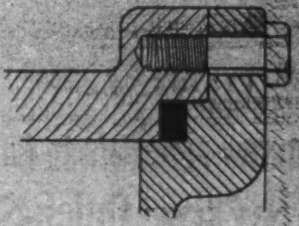
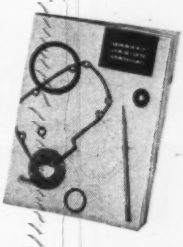


5.

A simpler solution to gasketing a metal-to-metal joint, however, is to use truly compressible materials such as cork composition or cork-and-rubber. With these materials, gasket volume and shape are not critical. Cork composition, for instance, can be cut to full channel width and twice the depth, yet it will compress into the cavity and permit perfect mating of the metal surfaces. Cork-and-rubber materials also combine the advantage of compressibility with the sealing properties of synthetic rubber.

You'll find other useful information on the design and use of gaskets in the new Armstrong Gasket Design Manual. Write for your copy of this manual to Armstrong Cork Company, Industrial Division 7105 Dean Street, Lancaster, Pennsylvania.

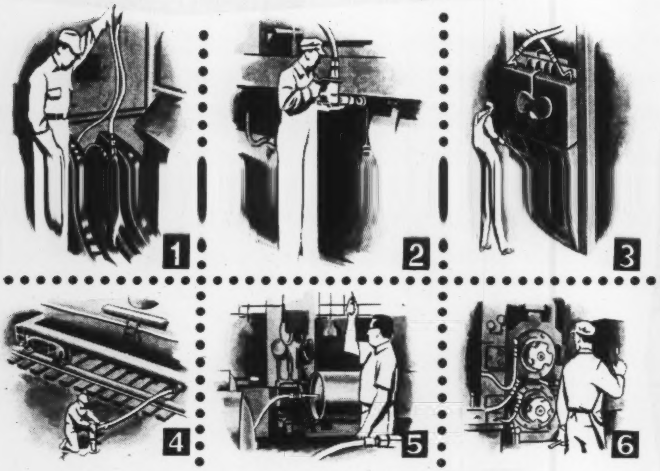


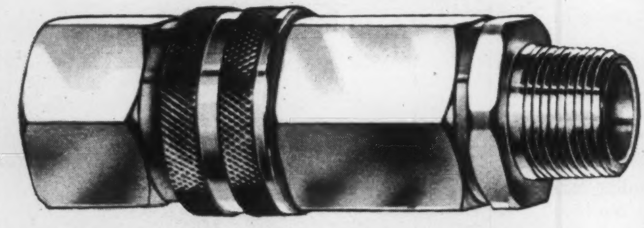
Armstrong

GASKET MATERIALS

... used wherever performance counts

—ITEM 566—





From raw materials to finished products—
Titeflex Quick-Seal Couplings
"make connections"... fast!

Quick-Seal couplings are absolutely leakproof. Couple and uncouple in just one second . . . *without* tools. And Quick-Seal couplings keep the lifelines of your operation open and flexible—allow *free* flow of liquids, gases, lubricants in any direction. Suitable for *all* industrial applications.

Check the drawings (above) for typical applications. Use it as a guide to uncover new profitable uses for Quick-Seal couplings in your plant.

1 High pressure testing
2 Diesel engine refueling lines
3 Furnace cooling water lines
4 Tank car unloading
5 Mass production testing
6 Rolling mill hydraulic lines

Titeflex

TITEFLEX, INC. Industrial Products Division
508 Hendee Street, Springfield 4, Mass.
Please mail your free Quick-Seal Coupling Catalog . . . without obligating us.

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Firm__________
Address__________
City__________ Zone__________ State__________

Titeflex Quick-Seal Couplings • *leakproof at all operating pressures, in every application*

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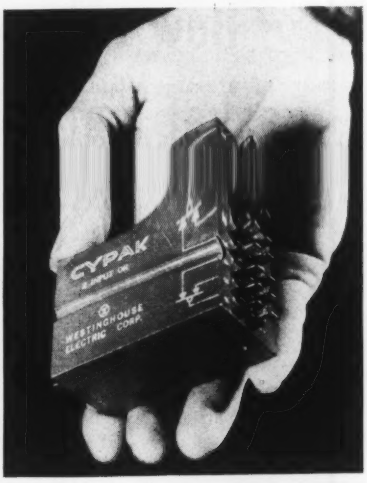


by 2-in. plug-in cartridges, encapsulated in polyester resin and fitted with terminals on the upper and lower faces. The modules plug into a power channel and are locked in place by studs to form a nearly solid assembly. Channels can be mounted side-by-side or end-to-end.

Assembly and maintenance are facilitated by numeral indentification of each terminal and by a logic diagram printed directly on each module. Phasing has been simplified by an external color dot that indicates how the unit should be positioned. Reversing the module's phase relationship is accomplished by removing the unit, reversing it, and plugging it in again.

Automation Seminar Scheduled for June

UNIVERSITY PARK, PA. — Automation will be the subject of an engineering seminar to be held at Pennsylvania State University this summer. Dates for the seminar are June 10-15.

Major topics will include product and systems analysis, linear programming, process controls, pneumatic systems, transfer and work-handling equipment, vibratory and hopper feed devices and manufacturing and assembly mechanisms. Workshop sessions will be held, and a panel will demonstrate how to develop an automation system.

Chester Linsky, assistant professor of industrial engineering, is in charge of the seminar and will be assisted by authorities in the field. Roger W. Bolz, editor of *Automa-*

tion, will present a paper dealing with product design for automation.

Meetings

AND EXPOSITIONS

May 14-17—
Design Engineering Show and Conference to be held at Convention Hall, Philadelphia. Additional information may be obtained from Clapp & Poliak, 341 Madison Ave., New York 17, N. Y.

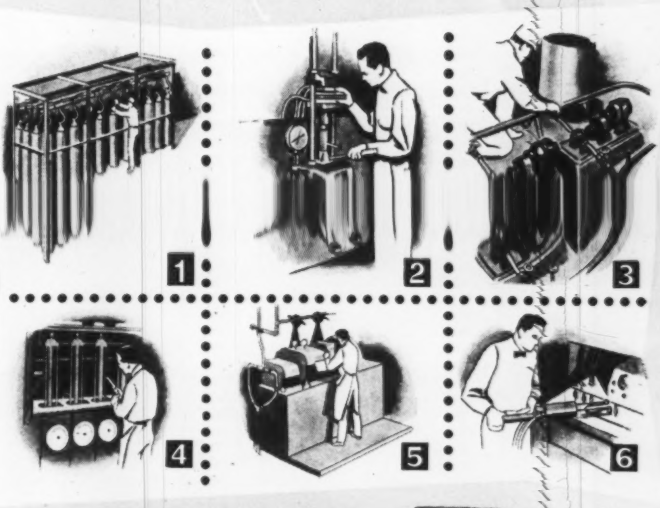
May 14-15
American Standards Association. Company Member Conference to be held in Cleveland. Open to all interested. Programs may be obtained from American Standards Association, 70 E. 45th St., New York 17, N. Y.

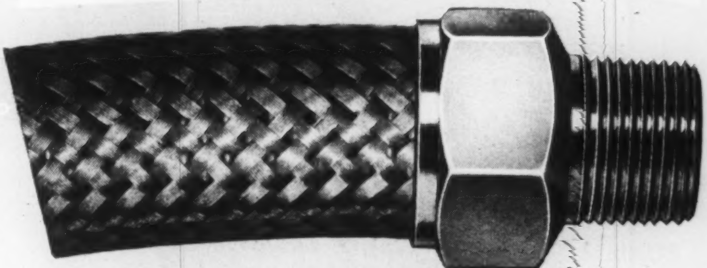
May 16-18—
Anti-Friction Bearing Manufacturers Association. Annual Meeting to be held at Princeton Inn, Princeton, N. J. H. O. Smith, 60 E. 42nd St., New York 17, N. Y., is secretary.

May 16-18—
Society for Experimental Stress Analysis. Spring Meeting to be held at the William Penn Hotel, Pittsburgh, Pa. Dr. W. M. Murray, P. O. Box 168, Cambridge 38, Mass., is secretary-treasurer.

May 17-18—
Society for Advancement of Management. First National Material Handling Conference to be held at Hotel Statler, New York. Additional information may be obtained from the Public Relations Dept., Society for Advancement of Management, 74 Fifth Ave., New York 11, N. Y.

May 23-24—
American Iron & Steel Institute. Annual Meeting to be held at the Waldorf-Astoria, New York. George S. Rose, 350 Fifth Ave.,





Here, there, everywhere in the plant... you find money-saving uses for Titeflex flexible metal hose

Here's the hose that licks critical corrosion, temperature, vibration and pressure problems in conveying gases, liquids, lubricants. *Universal* applications. All-metal construction. Braided or unbraided. Alloys to meet *every* need.

Investigate. Check the drawings (above) for ideas in the use of Titeflex Flexible Metal Hose in your plant. Use coupon to obtain information about this versatile and durable all-metal hose.

1 Fire extinguisher systems
2 Plastic presses
3 Food processing equipment
4 Electronic degassing equipment
5 Machine tools
6 High frequency conductors

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Please send your free Titeflex Flexible Hose Catalog without obligating us.

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TITEFLEX FLEXIBLE METAL HOSE licks corrosion temperature vibration pressures in all industrial operations

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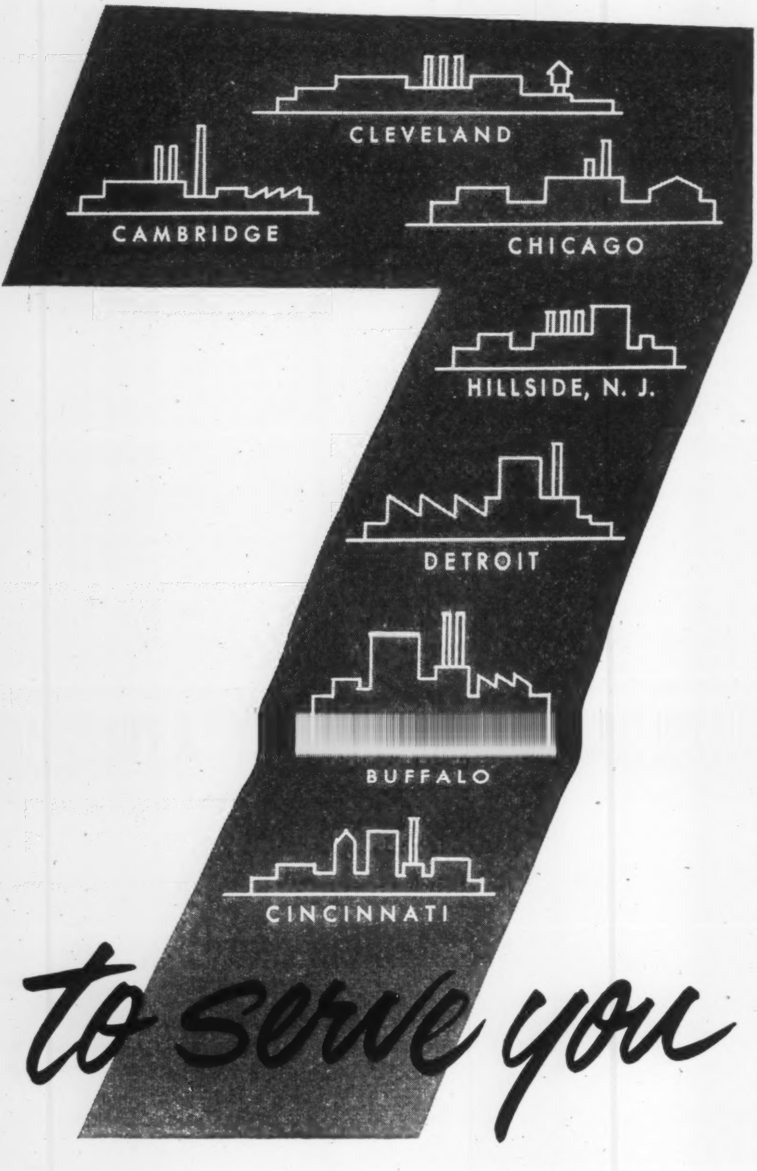

A call to any one of our seven warehouses will get you speedy service on your order . . . whether it's for *alloy steel bars, billets or forgings,* in any size, shape or treatment you need.

All seven warehouses are located in principal industrial areas. Each is modern and well-stocked, and staffed by expert metallurgists.

Call now if you need our own HY-TEN steels – "the standard steels of tomorrow", or standard AISI or SAE grades.

Or write for *free* copies of Wheelock, Lovejoy Data Sheets. They contain complete technical information on grades, applications, physical properties, tests, heat treating, etc.

In Canada: Sanderson-Newbould, Ltd., Montreal and Toronto

WHEELOCK, LOVEJOY & COMPANY, INC.

133 Sidney Street, Cambridge 39, Massachusetts

—ITEM 569—
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New York 1, N. Y., is secretary.

May 23-25—
American Society of Mechanical Engineers - Engineering Institute of Canada. Meeting to be held at the Mount Royal Hotel, Montreal, Quebec, Canada. Additional information may be obtained from A.S.M.E. headquarters, 29 W. 39th St., New York, N. Y.

May 23-26—
National Society of Professional Engineers. Annual Meeting to be held at the Ambassador Hotel, Atlantic City, N. J. Additional information may be obtained from society headquarters, 2029 K St., NW, Washington 6, D. C.

May 24-25—
National Warm Air Heating & Air Conditioning Association. First Technical Conference to be held at the Edgewater Beach Hotel, Chicago. Additional information may be obtained from society headquarters, 640 Engineers Bldg., Cleveland 14, O.

May 24-25—
Third Conference on Mechanisms to be held at Purdue University, West Lafayette, Ind. Sponsored by the Purdue School of Mechanical Engineering and MACHINE DESIGN. Additional information may be obtained from the Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

May 28-30—
National Fluid Power Association. Spring Meeting to be held at the Greenbrier, White Sulphur Springs, W. Va. Barrett Rogers, 1618 Orrington Ave., Evanston, Ill., is executive secretary.

June 3-6—
American Gear Manufacturers Association. Annual Meeting to be held at the Homestead, Hot Springs, Va. John C. Sears, One Thomas Circle, Washington, D. C., is executive secretary.

June 3-8—
Society of Automotive Engineers Inc. Summer Meeting to be held at the Chalfonte-Haddon Hall, At-

lantic City, N. J. Additional information may be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

June 5-8—
Materials Handling Institute Inc. Materials Handling Exposition to be held at the Public Auditorium, Cleveland, O. Additional information may be obtained from society headquarters, One Gateway Center, Pittsburgh 22, Pa.

June 14-16—
American Society of Mechanical Engineers. Applied Mechanics Division Conference to be held at the University of Illinois, Urbana, Ill. Additional information may be obtained from society headquarters, 29 W. 39th St., New York, N. Y.

June 17-20—
American Society of Agricultural Engineers. Annual Meeting to be held at Hotel Roanoke, Roanoke, Va. Frank B. Lanham, St. Joseph, Mich., is secretary.

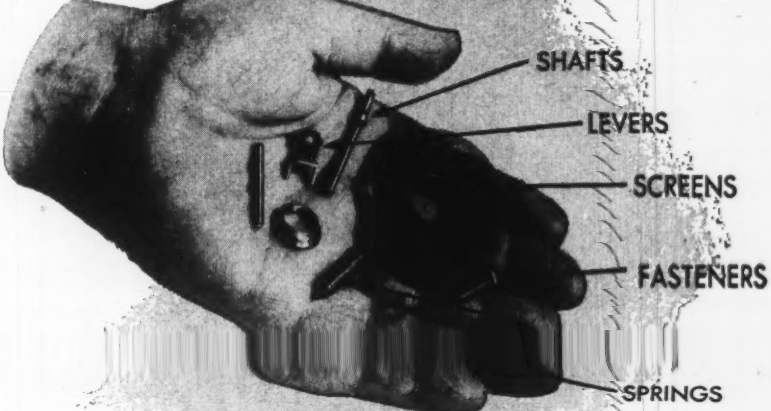
June 17-21—
American Electroplaters Society. Annual Meeting to be held at Hotel Statler, Washington, D. C. Additional information may be obtained from society headquarters, 445 Broad St., Newark, N. J.

June 17-21—
American Society of Mechanical Engineers. Semiannual Meeting to be held at Hotel Statler, Cleveland. Additional information may be obtained from society headquarters, 29 W. 39th St., New York, N. Y.

June 17-22—
American Society for Testing Materials. Annual Meeting and Apparatus Exhibit to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Robert J. Painter, 1916 Race St., Philadelphia 3, Pa., is executive secretary.

June 18-21—
Institute of the Aeronautical Sciences. Summer Meeting to be held at the IAS Bldg., Los Angeles. Additional information may be obtained from society headquarters, 2 E. 64th St., New York 21, N. Y.

ARE *small* PARTS CAUSING YOUR PRODUCT FAILURES?



It Will Pay You To Use ALLOYS

How many times can you trace your product failure to the corrosion, wear or breakage of some small part? A screw . . . a shaft . . . small spring . . . a gear or other seemingly insignificant part? In most cases the failure can be blamed on the material from which the part was made. The use of Nickel Alloys or Stainless Steel Wire, Rod or Strip for these parts could have saved many dollars in service and replacement costs because of their superior engineering properties.

How much more will alloy materials cost? Actually, on small parts, fabrication, finishing and other manufacturing costs will more than likely far overshadow material cost. You will find that the extra cost of using alloys will be insignificant compared with the benefits in longer service life, lower maintenance costs and fewer customer complaints.

For informative technical data on our alloys . . . and for some good ideas . . .

SEND TODAY FOR OUR NICKEL ALLOY AND STAINLESS STEEL DESIGN HANDBOOKS.

DESIGN HANDBOOK
of Stainless Steel

ALLOY
ALLOY METAL WIRE DIVISION
HKP H. K. PORTER COMPANY, INC.
Prospect Park, Pennsylvania
—ITEM 570—

V★S DRIVES

REEVES MOTOPULLEY

REEVES TRANSMISSION

WIDENING THE HORIZONS OF

Automation is the key to greater production of more goods and services at lower cost. The Tools of Automation can be applied profitably in a countless number of individual industries.

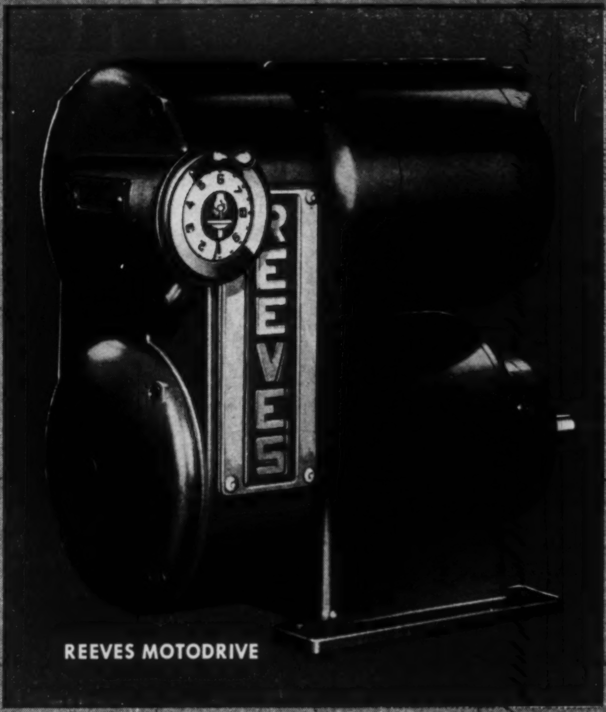
Reliance can provide *you* with valuable engineering assistance which can help secure the advantages of automation.

Our Tools of Automation consist of electric motors, variable-speed drives and controls.

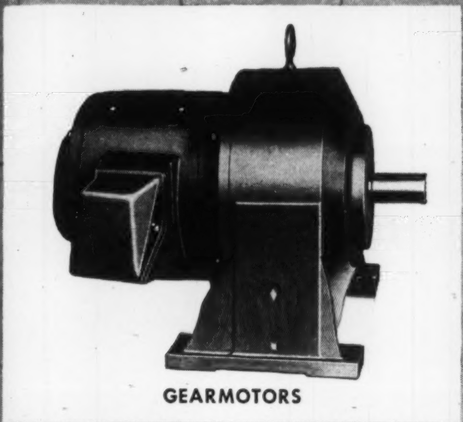
RELIANCE

"See us in Booth No. 220 at the Design Engineering Show."

TOTALLY-PROTECTED MOTORS



REEVES MOTODRIVE



GEARMOTORS

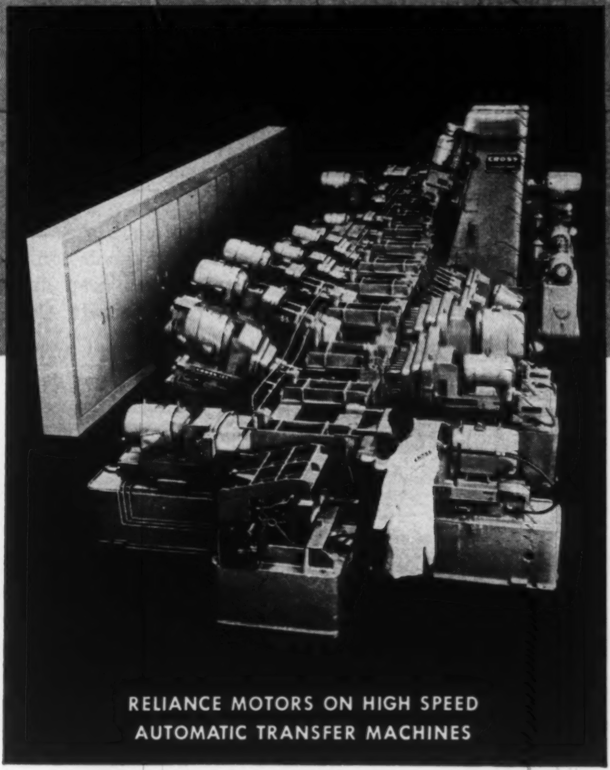
AUTOMATION

Application of these tools ranges from a single motor to multi-motor drives for highly complex production lines, where materials are processed into finished products in one continuous operation.

The world's largest manufacturer devoted exclusively to the production of quality motors and drives is ready to help you widen the horizons of automation in your plant.

Bulletin No. A-1555-B gives further details.

A-1519



RELIANCE MOTORS ON HIGH SPEED
AUTOMATIC TRANSFER MACHINES

ELECTRIC AND
ENGINEERING CO.

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Canadian Division: Welland, Ontario • Reeves Division: Columbus, Indiana
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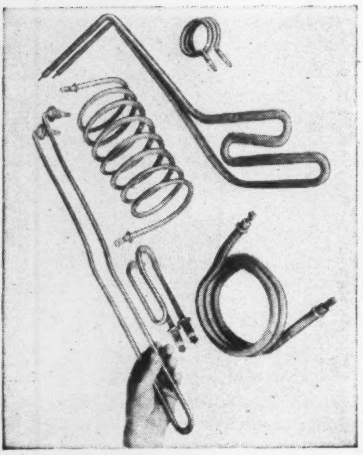


CHROMALOX
Electric
TUBULAR HEATERS

provide controlled and dependable conduction, convection or radiant heat

These versatile Chromalox Tubular Heaters provide the kind of heat you need, exactly fitted to your specific heating application.

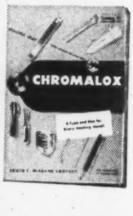
Available in straight lengths or formed to any desired shape. Used for heating dies, molds, platens; as immersion heaters in liquids, soft metal and molten salts; or in ovens, air ducts and other air heating applications.

Let the Chromalox Sales Engineering staff solve your heating problems . . . electrically

Write for your copy of Catalog 50

—for full information on the complete line of Chromalox Electric Heaters and controls.

For ideas on additional applications of electric heat, request Booklet F1550—"101 Ways to Apply Electric Heat."



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☐ a copy of "101 Ways"
☐ a Sales Engineer contact me.

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A-4466A

—ITEM 572—

Men of Machines

Benjamin L. Hummel and **Robert L. Stedfeld** have been promoted to associate managing editors of MACHINE DESIGN. Mr. Hummel joined the staff as an associate editor in March of 1950, and Mr. Stedfeld came to MACHINE DESIGN as an assistant editor in May, 1951. He was made an associate editor in September of 1952.

Benjamin L. Hummel

Robert L. Stedfeld

Appointment of **S. J. Pipitone** as manager of the design analysis department has been announced by Goodyear Aircraft Corp., Akron. He was formerly manager of airframe installations design and, before joining Goodyear, served as wing engineer with the Glenn L. Martin Co. for 13 years.

W. J. Purchas Jr. has been named chief engineer for the bearings department of Transmissions Operations by the Allison Div. of General Motors Corp. in Indianapolis. Mr. Purchas' 17 years of service with GM include assignments as draftsman, project engineer, senior engineer and chief engineer of diesel equipment.

Erickson Tool Co., Cleveland, has appointed **Harold Ruehl** chief engineer.

John E. McBrian recently joined the development engineering staff of North Electric Co., Galion, O., as a senior project engineer on electronics development.

Harold C. Miller has been named manager of magnetic recording research at Armour Research Foundation of Illinois Institute of Technology, Chicago.

Clarence A. Button, assistant to the executive vice president of the Mueller Brass Co., Port Huron, Mich., was elected president of the National Screw Machine Products Association at the association's recent annual meeting.

The Wright Brothers Medal was recently awarded by the Society of Automotive Engineers to **Wendell E. Reed,** Solar Aircraft Co. project engineer and inventor of the Microjet control for aircraft gas turbine power plants. Mr. Reed's paper, "A New Approach to Turbojet and Ramjet Engine

NEW Cramer

from face to terminal block

type 412

TIME DELAY RELAY

5
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SECONDS
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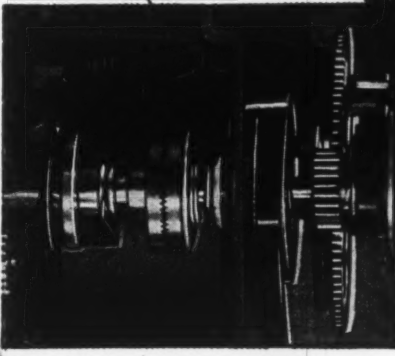
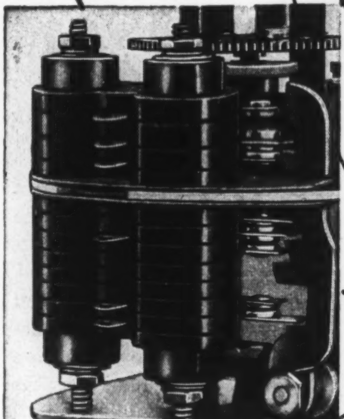
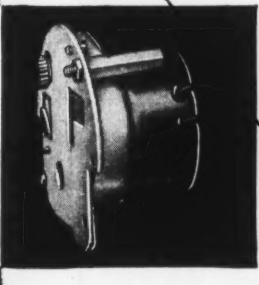






NEW—Repeat Accuracy within ± ¼ of 1% of full scale (30 sec. and longer ranges); ± ½ of 1% on faster timers.

NEW—Full Vision Dial. 300 degree scale assures precise settings and fast, accurate readings. Dial and pointers protected by transparent cover.

NEW Contacts, rated 15 amps., give positive quick-make, quick-break operation. Contacts are of silver cadmium oxide with ability to handle high inrush currents.

NEW Flexibility in wiring. Nine-position terminal block offers side or rear connection, presents a variety of wiring possibilities.

NEW Reset Shock Spring Design laboratory tested for more than a million operations.

NEW Friction Setting Mechanism allows adjustment even while timer is operating.

NEW—Ratchet Clutch operated by powerful relay, provides instant action, no slip.

NEW O-Ring Retainer permits quick removal of bakelite housing, exposing entire timer mechanism.

Timer driven by high torque (30 in. oz. at 1 r.p.m.) Cramer Type 112 Synchronous Motor.

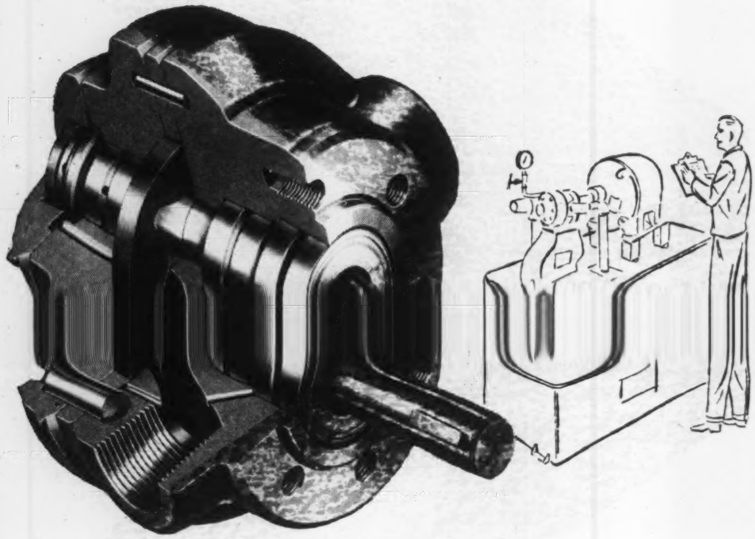
Cramer
TIMING
DEVICES

The R. W. CRAMER CO., Inc.

SPECIALISTS IN TIME CONTROL
BOX 6, CENTERBROOK, CONNECTICUT

10CR58

Gerotor
Hydraulic Pumps



give
Higher Efficiency
at Lower Operating Cost!

All Gerotor hydraulic pumps are recognized throughout industry for their outstanding design and performance. Heart of each unit is the exclusive *Gerotor* mechanism, both elements of which revolve in the same direction at relative low speed. This results in *longer life*, *less slippage*, *less wear*, a *smoother*, more *uniform flow*. In your plant or in your product—a GEROTOR pump means *higher efficiency* at *lower operating cost*.

Due to modern production facilities, GEROTOR can produce special pump designs in *quantities* on an economical basis. Whatever your hydraulic pump problems, bring them to GEROTOR.

Free literature available . . . *write:*

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1537 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

MANUFACTURERS OF—
Hydraulic Pumps and Motors
Variable Speed Hydraulic Transmissions
PneuBin—Pneumatic Bin Evacuators

Control," presented at the SAE national meeting last October, was judged the best presentation on aeronautics in 1955.

Francis H. Gerlach has been named vice president and engineering manager of Lamb Electric Co., Kent, O. He joined the company in 1953 as manager of engineering. Mr. Gerlach had been chief engineer of Fasco Industries Inc. and also spent 11 years in the small motor section of Westinghouse Electric.

Francis H. Gerlach

Lamb also advanced **H. F. Doll** to vice president and plant manager. **Walter H. Poesse** and **Milton H. Spielman,** two founders of the original company, have resigned as vice presidents but will continue as consultants.

Melvin B. Kline has been named manager of the Missile Engineering Department of Allen B. du Mont Laboratories Inc., with headquarters in Los Angeles. Mr. Kline was formerly manager of government and special products engineering for the Technical Products Div. He joined Du Mont in 1941 as an electronic engineer.

Formsprag Co., Van Dyke, Mich., recently announced the election of **L. T. Szady** to vice president in charge of engineering. Mr. Szady joined Formsprag as a design engineer in 1946 and was

L. T. Szady

named chief engineer in 1950. He previously served as project engineer and design engineer at the Gear Grinding Machine Co.

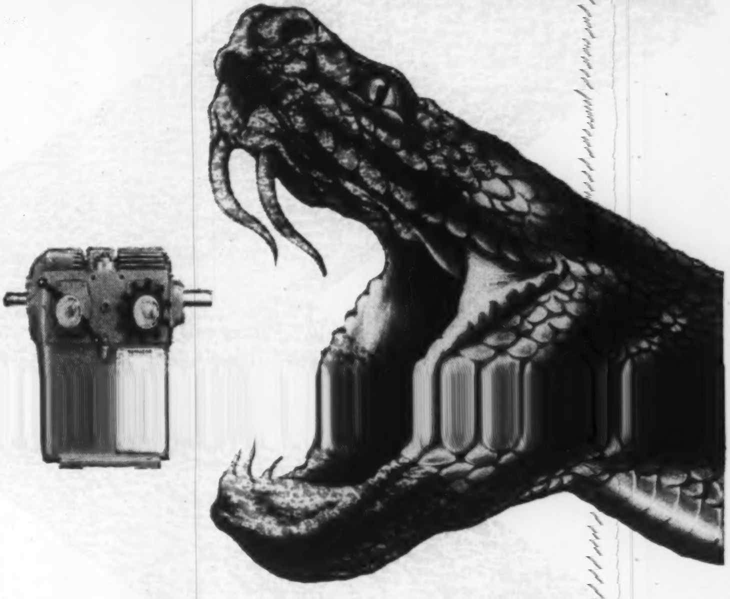
Philip S. Hessinger has been appointed research and development engineer of Mycalex Corp. of America. He will be responsible for new product development and research at the company's Clifton, N. J. plant.

Ace Electronics Associates, Somerville, Mass., has appointed **Warren Roberts** engineer in charge of quality control.

The appointment of **William E. Taylor** as chief engineer of the Materials Research Department of the Semiconductor Products Div. has been announced by Motorola Inc., Chicago. Dr. Taylor has been associated with the Motorola semiconductor program since its inception in 1952.

Bendix Aviation Corp. recently appointed **Wallace C. Caldwell** to head a new department for expanded research into and production of transistors at the Red Bank Div. in Eatontown, N. J. Dr. Caldwell has been chief engineer of the division's electron tube plant for the last four years. He is succeeded by **John H. Wyman,** former chief project engineer for special-purpose electron tubes.

We wore out 110,000 Rattlesnakes



Have you ever been awed by the rapidity with which a rattler strikes and recoils? You should be! Old "diamond-back" can lash out and reverse himself in about 1/10th of a second. There's one catch—he wears out after a second or so of continuous activity.

Rapid Reversing

can be fatiguing for machinery as well as rattlesnakes, but . . . for the record, we reversed a GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION (under load) over a million times—continuously at a rate of 22 times per minute—without the slightest sign of wear to the Gerotor Transmission.

If your operation demands rapid reversing, infinitely variable speeds, constant or variable torque and horsepower—all with positive overload protection—check on the new GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION.

Write:

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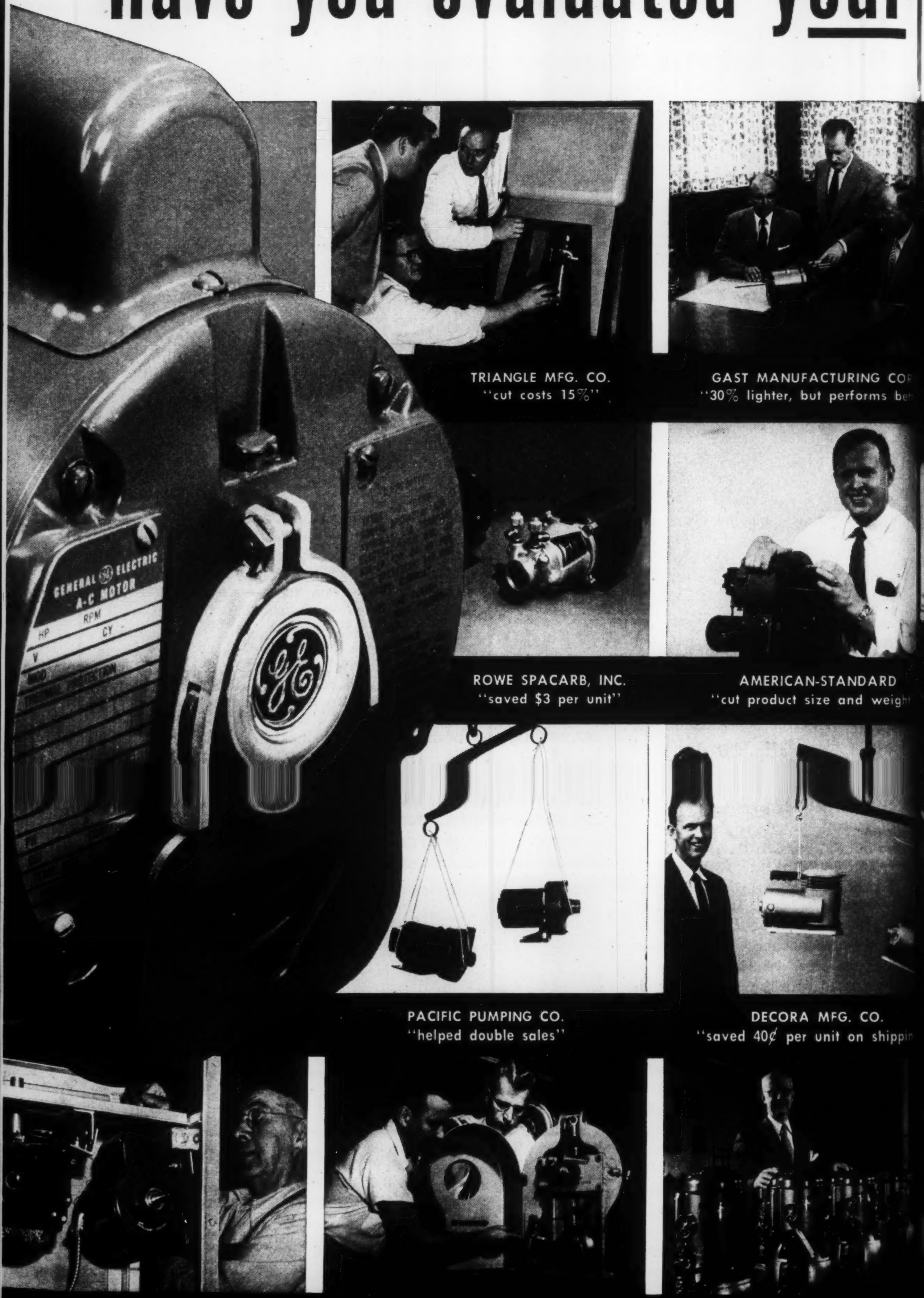
Hydraulic Pumps and Motors
Variable Speed Hydraulic Transmissions
PneuBin—Pneumatic Bin Evacuators

Have you evaluated your



TRIANGLE MFG. CO.
"cut costs 15%"

GAST MANUFACTURING COR
"30% lighter, but performs be

ROWE SPACARB, INC.
"saved $3 per unit"

AMERICAN-STANDARD
"cut product size and weigh

PACIFIC PUMPING CO.
"helped double sales"

DECORA MFG. CO.
"saved 40¢ per unit on shippin

SWEDEN FREEZER MFG. CO.
"most dependable motor"

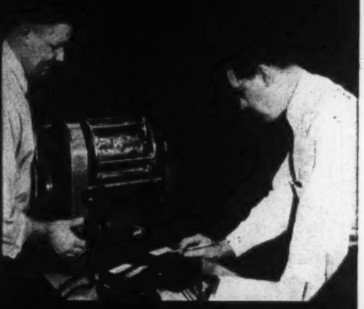
AIRCRAFT-MARINE PRODUCTS, INC.
"extremely low service expense"

DEMING COMPANY
"saved on handling and ship

XUM

motor savings yet?

AMERICAN BLOWER CO.
"reduced motor stocks"



A. B. DICK CO.
ch more value for your money"

UNIVERSAL INDUSTRIES
elped make peeler portable"

FINNELL SYSTEM, INC.
00% standardized on G.E."

TODAY THOUSANDS OF COMPANIES CUT COSTS, BOOST QUALITY WITH ADVANCED G-E MOTORS

In the past four years, equipment manufacturers have bought nearly 5,000,000 smaller, lighter G-E fractional-hp motors. Today, they testify to the *tangible, measurable benefits* they have realized. For example:

MANUFACTURING AND SHIPPING SAVINGS amounting to about 15% resulted from a Detroit pump manufacturer's* decision to switch to advanced-design G-E motors. Rugged construction of the G-E motor permitted direct mounting, eliminated several parts. Lighter weight reduced worker fatigue, helped speed assembly—shipping and packaging savings alone were 30¢ per unit! Result: a better-looking, more efficient unit which sells at a 10% lower price!

GREATER POWER AT NO EXTRA COST helped a Chicago office machine manufacturer* boost the saleability of his product. Lower handling, shipping, and assembly costs, modern appearance, and the sales value of the G-E monogram cause this well-known manufacturer to credit the G-E motor with making it "easier to design, build, ship, and sell" his machines.

UNSURPASSED DEPENDABILITY of the "years-ahead" G-E motor is a proven fact to thousands of manufacturers. A typical experience is that of a California compressor manufacturer*, who introduced a G-E powered paint sprayer over two years ago. To date 99.9% of these units have never required motor service.

TREMENDOUS SALES APPEAL of products designed to take advantage of all the G-E motor benefits is typified by the case of a West Coast pump manufacturer*. Just one year after introducing a streamlined new unit, made smaller and easier to handle by the G-E motor, his manufacturing costs had been reduced and his ***sales had doubled!***

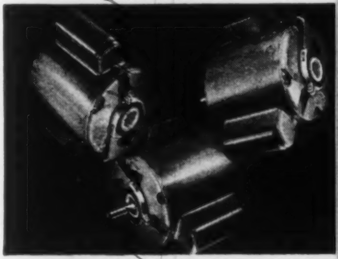
"Years-ahead" design and proved performance of the G-E motor are helping to establish the leaders in many fields. If you'd like more information, or help in taking greater advantage of the G-E motor's benefits in your products, contact your nearby G-E Apparatus Sales Office, or write to Section 702-24, General Electric Co., Schenectady 5, New York.

**Actual case histories available on request.*
†Dupont trade-mark for polyester film

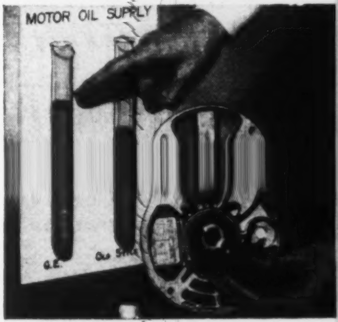
ONLY G.E. OFFERS
ALL THESE FEATURES

MORE COMPACT—up to 40% smaller, 50% lighter—saves you material and handling costs.

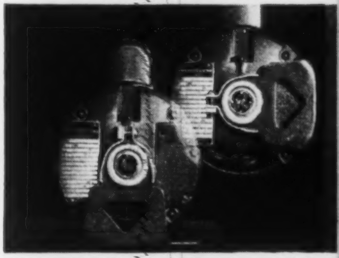
MYLAR† INSULATION (right)—35 times the moisture resistance of paper insulation (left).



ALL-ANGLE OPERATION—protective lubrication in any position—without costly specials.



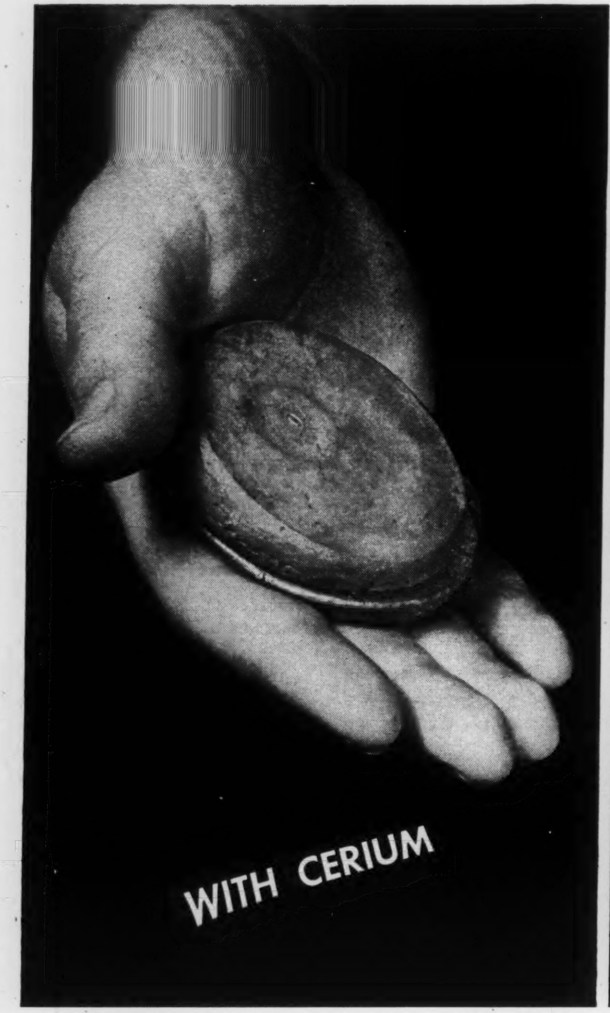
DOUBLE LUBRICATION LIFE—50% more oil, efficient retention system cut maintenance.



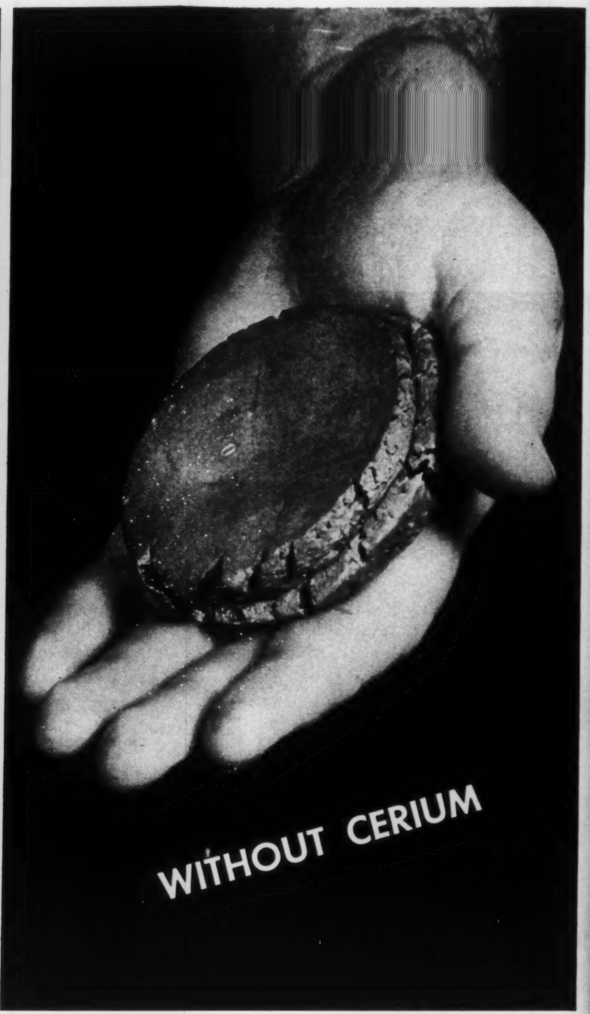
MOUNTING VERSATILITY—rotate motor in resilient *or solid base.* Cradle easily removed.

Progress Is Our Most Important Product

GENERAL ELECTRIC



WITH CERIUM



WITHOUT CERIUM

HOW *Carpenter* USES RARE EARTH ELEMENTS TO IMPROVE FORGEABILITY OF ALLOYS FOR ELEVATED TEMPERATURE SERVICE

The value of rare earth elements in certain alloys for elevated temperature service can be seen in this hot forgeability test. Cast cones, identical except for the addition of cerium in one, are heated to forging temperature and upset or hammered into flat "pancakes". Note the relative freedom from cracks and tears in the specimen containing cerium.

What does this improved hot workability mean to you? It means better forged finishes requiring less machine clean-up . . . less wasted steel . . . fewer rejects . . . faster fabricating.

Carpenter alloys for elevated temperature service have an enviable reputation for improved forgeability, and

exceptional cleanness which meets the strictest inspection requirements.

Carpenter pioneering in tool steels, super corrosion resisting steels and free-machining stainless steels has helped hundreds of companies to improve products and cut costs. This same specialty mill experience can help you do a better, low cost job on any parts or products you make for high temperature service. It'll pay you to investigate. Contact your Carpenter Representative, or drop us a line on your company letterhead. *The Carpenter Steel Company, 120 W. Bern St., Reading, Pa.*

Specify Carpenter alloys for elevated temperature service and get these three big advantages . . .

Improved Forgeability
Greater Uniformity
Cleaner Steel

Carpenter STEEL

Improved Alloys for Elevated Temperature Service

—ITEM 577—
For More Information Circle Item Number on Yellow Card—page 19

DU PONT
REG. U. S. PAT. OFF.
Better things for Better Living
. . . through Chemistry

PRODUCT ENGINEERING NEWS
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."
No. 6, 1956

Gears and housing of ZYTEL® nylon resin permit simplified, more compact paintbrush-cleaner design

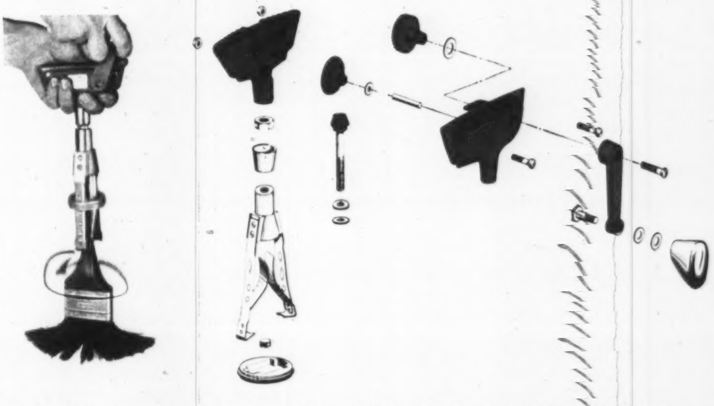


Photo of "Spin-A-Brush" cleaner in use, with exploded view showing parts of "Zytel" in red. (Parts molded by Process Gear Company and Chicago Molded Products. Manufactured by Portable Electric Tool Company, Chicago, Illinois.)

THIS hand-operated paintbrush cleaner has been designed for home or professional use. The lightweight, compactly designed unit will clean a paintbrush or paint roller in approximately ninety seconds.

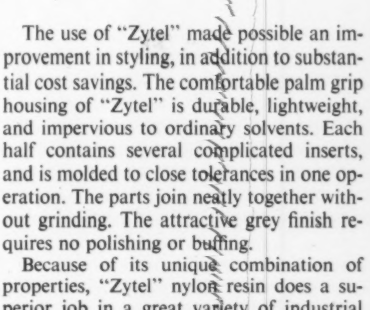
A handle actuates molded gears of "Zytel", set at a 1 to 8 ratio, which spin the brush. These smooth-operating gears of "Zytel" require no lubrication and reduce backlash considerably. A self-tapping metal screw attaches the initial gear to the handle, locking the gear securely and permanently in place.

"Zytel" nylon resin was selected for this application because it is accurately and inexpensively injection molded and requires no further finishing. The bevel gear and spur of "Zytel" mold as a unit, eliminating a costly machining and assembly operation.

The use of "Zytel" made possible an improvement in styling, in addition to substantial cost savings. The comfortable palm grip housing of "Zytel" is durable, lightweight, and impervious to ordinary solvents. Each half contains several complicated inserts, and is molded to close tolerances in one operation. The parts join neatly together without grinding. The attractive grey finish requires no polishing or buffing.

Because of its unique combination of properties, "Zytel" nylon resin does a superior job in a great variety of industrial applications. "Zytel" is distinguished by its toughness, form stability at high temperatures, and chemical resistance. Be sure to investigate Du Pont "Zytel" nylon resin. Complete property and application data are available to you without cost or obligation.

Flexibility of ALATHON® assures close fit, positive protection in dust masks



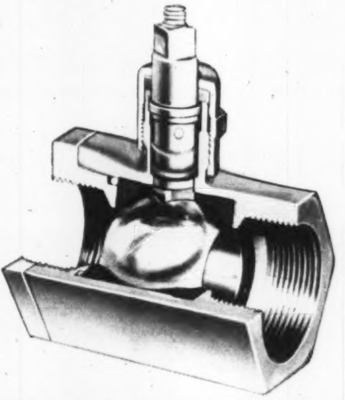
"Alathon" polyethylene resin plays a key part in this new paint and dust mask, which affords improved protection and comfort to both commercial and home users.

One of the major difficulties in protective masks—air leaks around the frame—has now been eliminated. The frames of "Alathon" are contoured and flexible, making them adjustable. Serrations on the inner edge of both frame members provide an airtight filter lock.

"Alathon" makes possible other protective benefits. Non-toxic "Alathon" is unaffected by paint or perspiration and can be easily sterilized. It is tough—unbreakable in normal usage. Du Pont "Alathon" polyethylene resin can be injection molded, providing economy to the manufacturer. (Manufactured by Flexo Products, Inc., Cleveland 13, Ohio.)

OVER

Ball valve seats of TEFLON® provide tight, long-lasting, chemically inert seals



"Double-seal" ball valve manufactured by the Jamesbury Corporation, Worcester 5, Massachusetts. Processors—Crane Packing Company, Chicago, Illinois, and United States Gasket Company, Camden, New Jersey.

WITH SEATS of "Teflon", these valves are able to handle practically all known liquids and gases—through extreme temperature ranges. They also offer the advantage of economy by reducing maintenance time.

"Teflon" tetrafluoroethylene resin is inert to all chemicals normally used in industry. Only alkali metals and fluorine under special conditions affect "Teflon".

"Teflon" is non-flammable and has zero water absorption. Its chemical inertness, heat resistance (working temperature range of "Teflon" extends from −450°F to 500°F), resiliency and toughness recommend "Teflon" for use in gaskets, packings and component parts of pumps, agitators, mixers and for valve seats and discs.

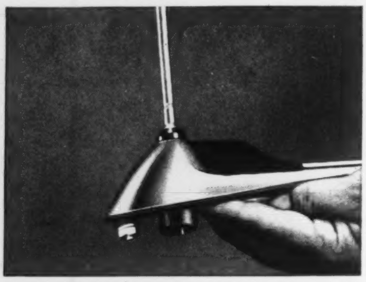
Investigate the benefits of using "Teflon" in your own applications. No other single material serves so well over such a wide range of conditions.

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living . . . through Chemistry

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

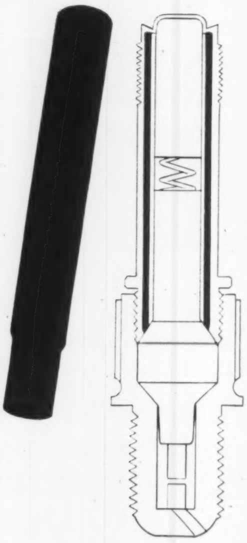


LUCITE® provides beauty and durability for antenna base

Du Pont "Lucite" acrylic resin adds a decorative touch to this auto radio antenna. "Lucite" was selected by Ford Motor Company for this job, because it is available in a wide range of attractive, non-fading colors and is unaffected by weather.

"Lucite" is shatterproof, light in weight, chemical resistant, and easy to keep clean. Because of this excellent balance of properties, Du Pont "Lucite" acrylic resin can solve a wide variety of product design problems involving long-term light transmission and outdoor weathering. "Lucite" is fabricated economically by injection and compression molding, extrusion and forming. For further information, use the coupon at the bottom of this page. (Molded by Sajar Plastics, Inc., Middlefield, Ohio. Manufactured by Tenna Manufacturing Company, Cleveland 25, Ohio.)

TEFLON® offers superior electrical and mechanical properties for aircraft spark plug insulators



Cutaway view of aircraft spark plug, showing two insulation sleeves of "Teflon" tetrafluoroethylene resin in red. (Spark plug manufactured by the Jet Ignition Company, Larchmont, New York. Sleeves of "Teflon" by Raybestos-Manhattan, Inc., Manheim, Pennsylvania.)

"Teflon" replaces ceramic . . . eliminates breakage problems

Two thin sleeves of "Teflon" tetrafluoroethylene resin outperform the ceramic insulator found in conventional aircraft spark plugs. The use of "Teflon" virtually eliminates the possibility of failure resulting from dropping, mishandling, normal engine vibration or other mechanical injury to the barrel of the plug.

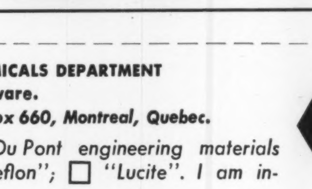
During the development and testing of the plugs, failure with standard ceramic sleeve insulators was experienced at 150 to 200 hours of operation. Failures were invariably due to the cracking of the ceramic insulator. No cracking has been observed with insulators of "Teflon", even after prolonged testing.

The insulating properties of "Teflon" are far superior to those of the ceramic sleeve. You will note from the illustration that two sleeves of "Teflon" are used—one inside the other. This provides added protection against dielectric failure.

Aircraft engine plugs with sleeve insulators of "Teflon", as illustrated, are approved by the CAA for use in the R-1820 engine and the Franklin 0-335-5 and 0-335-6 engines and are in use in these engines at the present time.

The mechanical, electrical, and chemical properties of "Teflon" have found use in a variety of design applications. Do you require material that is chemically inert? Suitable for use at extreme temperatures? Tough and resilient? For complete property data on this versatile Du Pont engineering material, mail the coupon at left.

Gear movement of "Zytel" nylon resin in Pluto novelty clock offers lightweight, compact design—plus smooth, quiet operation, with no lubrication. "Zytel" nylon resin is injection molded and requires no further finishing. Its strength and stiffness, even in thin sections, assure parts which will provide years of trouble-free service. (Clock by Allied Manufacturing Company, Seattle 44, Washington.)



E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 125, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ "Zytel"; ☐ "Alathon"; ☐ "Teflon"; ☐ "Lucite". I am interested in evaluating these materials for:

____

NAME______________________ POSITION______________

COMPANY______________________________

STREET______________________________

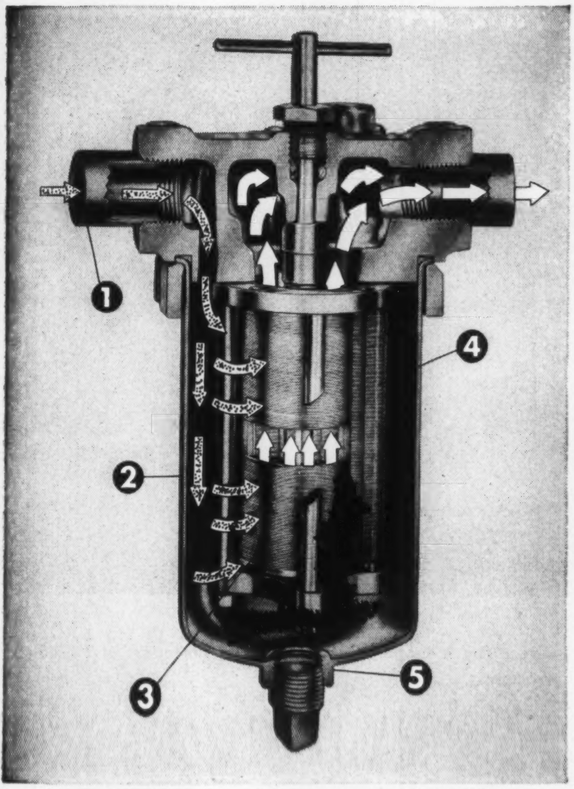
CITY______________________ STATE______________

TYPE OF BUSINESS______________________________

NEED MORE INFORMATION?

For complete details that will help you further evaluate the Du Pont engineering materials for use in your product development programs, mail the coupon at the left. Specific property and application data will be sent to you.

NOW! 40-micron, self-cleaning filter
It's the new Cuno SUPER Auto-Klean



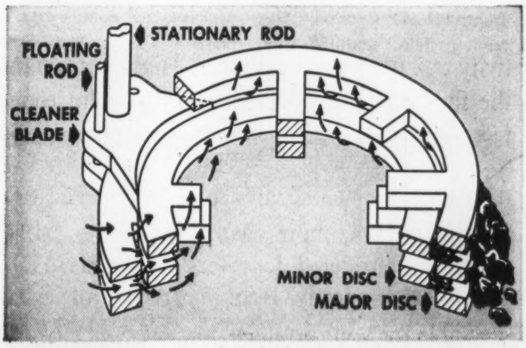
HOW IT WORKS. Dirty oil enters inlet (1) at left, fills housing (2) and flows through metal edge-type filter (3). Clean oil rises through center of filter, leaves at right. Dirt combed out by cleaner blades (4) is removed through drain (5).

Cuno's new SUPER Auto-Klean is the first practical, compact micronic filter for lubricating oil, hydraulic fluid, coolant, fuel, and other industrial fluids.

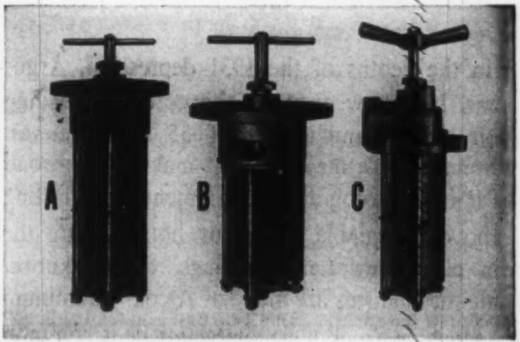
Many times smaller than other micronic filters of equal capacity, Cuno's new SUPER Auto-Klean filter now makes possible economical, micronic filtration at high flow rates and eliminates the need for replacement cartridges in most cases. Here's what it offers:

1. **Full-flow** 40-micron filtration with a self-cleaning filter. Positive protection against particles larger than 40 microns (actually 0.0015 in.). All-metal filter can't rupture or channel.
2. **Easy cleaning.** Just turn the handle—by hand or continuously with motor drive. No interruptions for cleaning.
3. **No cartridge changes.** Ends operating costs if you've been using cartridge filters.
4. **Low pressure drop, no pressure drop build-up.** An 8" by 2¼" SUPER Auto-Klean filters 30 gpm of 200 SSU oil with only 3 psi pressure drop—up to 75% more with slightly higher pressure.
5. **High capacity in a small package.** Many times smaller than replaceable-cartridge type filters of equal capacity, it saves with lower initial costs, lower installation costs.
6. **Easy to build into new equipment.** Available for line-type housings *(left)* or incorporation in sump or reservoir *(below.)* Works in any position.
7. **Easy to install in old equipment.** Fits existing Auto-Klean housings. You can easily replace most 2¼" diameter elements with SUPER Auto-Klean for finer filtration.

Write today for complete technical data on the new SUPER Auto-Klean for your new or existing equipment. Ask for Catalog No. SAK-057. Cuno Engineering Corporation, 14-5 South Vine Street, Meriden, Connecticut. 59



FILTER ELEMENT consists of stacked major and minor discs and cleaner blade bearing against minor discs. Small arrows show flow. Short restrictions between minor and major discs stop 40-micron particles but allow high flow rate.



FILTERS FOR INTERNAL PIPING *(A and B above)* allow streamlined design plus the best infiltration. Flange mounting with external outlet *(C above)* and line-type *(large cutaway above left)* are just a few of many other possibilities.

CUNO *ENGINEERED FILTRATION*

See this and other Cuno filters at
Booth No. 403, Design Engineering Show,
Philadelphia—May 14-17

AUTO-KLEAN (edge-type · MICRO-KLEAN (fibre cartridge) · FLO-KLEAN (wire-wound) · PORO-KLEAN (porous metal)

—ITEM 579—

For More Information Circle Item Number on Yellow Card—page 19

A typical new product planning session at Argus includes, from left to right: N. L. Symons, Director of Purchases; G. D. Flannery, Purchasing Agent; M. K. Carr, Chief Product Engineer; J. N. Steel, Advertising Manager; C. F. Myers, Superintendent of Mechanical Processing.

A VISIT TO ARGUS* TO SEE WHAT THEY'RE DOING WITH ALCOA SCREW MACHINE STOCK

Born in the depths of the 1931 depression, Argus Cameras, Inc., now occupies the country's leading position as a manufacturer of 35 mm cameras. Aluminum plays a major role in making the broad Argus line of photographic equipment light, lasting and above all salable. Projector housings are die cast in aluminum. Lens housings, rewind knobs, focusing mechanisms are made of Alcoa® Aluminum Screw Machine Stock. One characteristic is common to all screw machine parts made by Argus. That characteristic is precision. Tolerances in "tenths of thousands" are commonplace. Diamond turned finishes are routine. Jewel-like appearance is a production byword.

Although quality appearance is mandatory at Argus, it may not be a requirement of your product. Consider, then, the other reasons why the trend to aluminum screw machine parts can no longer be bucked: excellent machinability of today's free-cutting Alcoa alloys . . . electrical and thermal conductivity . . . corrosion resistance. High performance of the finished part, coupled with the solid economic fact that you get three times as many parts per pound as with heavy metal, makes up the total "good sense" of aluminum. These are hard commercial reasons why aluminum, more than ever before, should be carefully considered for every screw machine part you make or specify. Help in this type of analysis is available for your product from every one of Alcoa's local sales offices listed in your phone book under "Aluminum." ALUMINUM COMPANY OF AMERICA, 873-E Alcoa Building, Pittsburgh 19, Pennsylvania.

*argus Cameras Inc.

Purchasing session on aluminum screw machine parts and stock is held by: N. L. Symons, Director of Purchases (left) and Purchasing Agents, L. H. Thomas (center) and G. D. Flannery (right).

Design consultation on aluminum parts includes: Chief Product Engineer, M. K. Carr (standing) and Assistant Chief Product Engineer, E. O. Zill (seated).

Inspecting fine finish on aluminum lens mounts are: A. E. Danner, Shop Foreman (left) and C. F. Myers, Superintendent of Mechanical Processing (right).

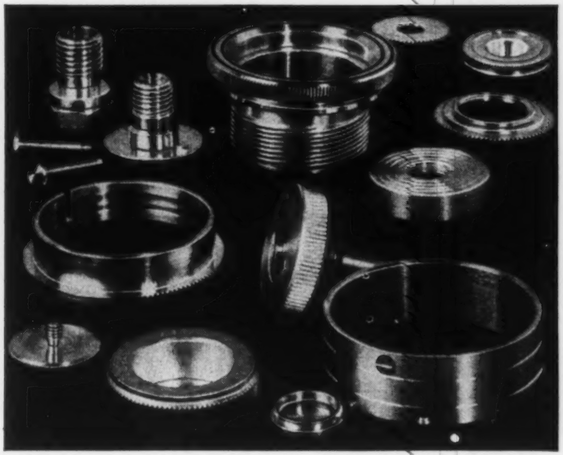
IN PURCHASING

"Our purchasing department at Argus demands dependability from suppliers. It is this single fact that has characterized our relationship with Alcoa over the past 11 years. We have never had a reject of Alcoa Screw Machine Stock. Alcoa's research and development aid are always available when needed. We don't believe you could ask more of a supplier than we get willingly from Alcoa."

IN DESIGN

"The low cost of aluminum is a tremendous factor in the manufacture of a volume product like cameras. But beyond that, we in design lean heavily on aluminum for the better product it makes possible. Light weight and corrosion resistance are mandatory in cameras. The permanent black anodized finish, possible with aluminum, has led to its use in place of brass for some parts like lens-retaining rings. Freedom from plating makes parts like lens mounts and focusing mechanisms more practical in aluminum than brass or steel.

"In design considerations, the combination of Alcoa literature and Alcoa technical assistance gives us firm foundations of fact on which we can make decisions."



Typical parts machined by Argus from Alcoa Aluminum Screw Machine Stock.

IN PRODUCTION

"We machine aluminum at tremendous feeds and speeds. Many of our parts require 75% stock removal. For these, the machinability of aluminum and its high scrap value stand us in good stead. The fine finish, so necessary to camera parts, is easily attainable with Alcoa Screw Machine Stock. And in this respect, consistency of quality from one shipment to the next is perhaps the place where Alcoa serves us best. Fine threads and close tolerances are second nature to us. We like the way aluminum gives us these qualities without constant tool change and lost setup time."

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

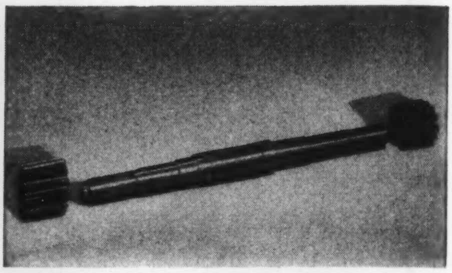
Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM
SCREW MACHINE STOCK
ALUMINUM COMPANY OF AMERICA

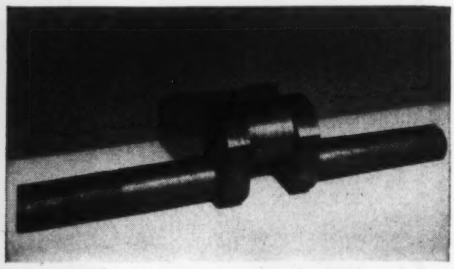
—ITEM 580—

For More Information Circle Item Number on Yellow Card—page 19

Output up...costs down in plant operating eight presses with Ductile Cast Iron dies, shafts, gears, drums, shoes and the like. State Foundry and Machine Co., Cedar Grove, Wisc., licensed by Inco to produce Ductile Cast Iron, turns out replacements that far outlast previously used materials.



Breakage problem solved. Ductile Cast Iron used on all 8 presses for backshafts. 5′ long and 6″ at widest diameter, with 1″ air hole in center bore, Ductile Iron units need no 8-hour replacement jobs every two months.



Longer life comes from strength and toughness of Ductile Cast Iron. Yet you can readily machine the fine-grained, wear-resistant Ductile Cast Iron used for this heavy-duty crankshaft.

Still good after stamping 875,000 blanks (left) into cases (right). This Ductile Cast Iron die, oil quenched from 1750°F, and stress-relieved at 375°F, develops 55-58 Rockwell C.

Engineers extend life of press parts... up to 18 times with Ductile Cast Iron

IMPRESSIVE RECORDS come from eight 135-ton presses that stamp out 20-mm cartridge cases.

1. Where tool steel dies averaged forty to sixty thousand cases . . .

> *875,000 cases are now punched out by Ductile Cast Iron dies.*

2. Where steel backshafts supporting 3000-pound clutch assemblies failed in about two months . . .

> *Ductile Cast Iron backshafts have so far served 10 months.*

3. Where gray iron brake drums lasted six months maximum . . .

> *Ductile Cast Iron replacements still operate after 18 months.*

Other advantages

As press parts of cast iron and steel wore out or broke, Ductile Cast Iron replacements took over. That reduced downtime, production costs and maintenance, too.

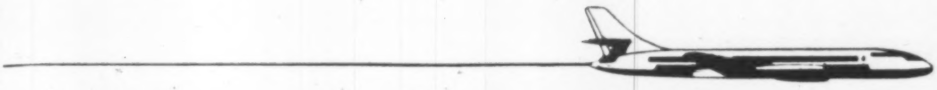
Despite its high wear resistance, Ductile Cast Iron is easy to machine. This advantage saves both time and labor . . . a factor to consider in selecting material for almost any application.

Now replacing more costly materials in many fields, Ductile Cast Iron behaves better in the shop as well as on the job. Get the full story of this economical iron. It's several times stronger than gray cast iron and up to 12 times tougher. Send for a copy of "DUCTILE IRON, The Cast Iron THAT CAN BE BENT!" It's filled with helpful data. Write for your copy now.

ductile iron . . . the cast iron that can be twisted and bent

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street, New York 5, N. Y.

—ITEM 581—
For More Information Circle Item Number on Yellow Card—page 19

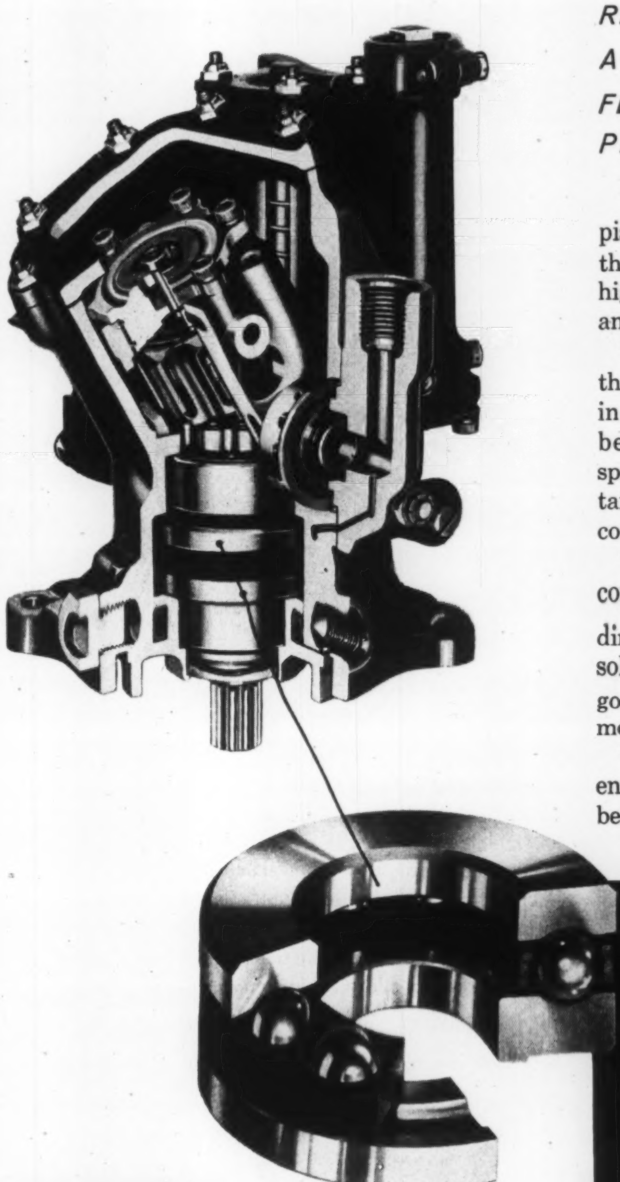


IN THIS IMPROVED PRESSURIZATION PUMP

ONE AETNA BEARING DOES A FORMER *TWO* BEARING JOB

RESULT:

*A LIGHTER, SMALLER PUMP WITH FEWER PARTS **PLUS** IMPROVED PERFORMANCE AND RELIABILITY*

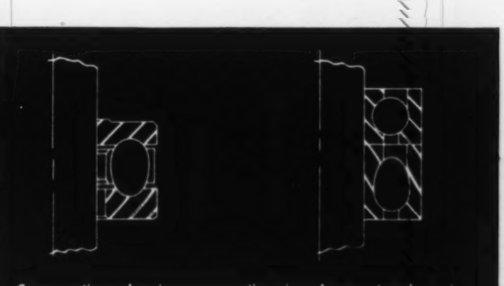


This recently improved variable displacement piston type pump packs more power in less space than any other pump made—has, in fact, notably higher efficiency with a third less of the weight and size of its previous design.

To achieve this significant miniaturization job the pump makers turned to Aetna for assistance in "shrinking" the all-important anti-friction bearing units. You see the result here: one special, space-conserving Aetna thrust bearing tailored to do the job that formerly required two conventional-size angular contact bearings.

This example of how Aetna is helping industry compress its products into smaller, cost-cutting dimensions is not at all exceptional. For 40 years solving difficult friction problems to help make good products better has been one of Aetna's most intensified engineering activities.

We invite you to use that wealth of specialized engineering knowledge whenever you have a ball bearing, roller bearing or precision parts problem.



Cross sections showing comparative size of present and previous bearings. When conserving space is important (as it is in everything aeronautic) dimensional savings like this are real contributions to the aviation industry. Could your product benefit in the same way?

Aetna

1916 40 YEARS 1956 FIGHTING FRICTION

AETNA BALL AND ROLLER BEARING COMPANY

Division of Parkersburg-Aetna Corporation

4611 SCHUBERT AVENUE • CHICAGO 39, ILLINOIS

Manufacturers of: Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Radial Ball Bearing Mounted Units • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Parts

—ITEM 582—

For More Information Circle Item Number on Yellow Card—page 19

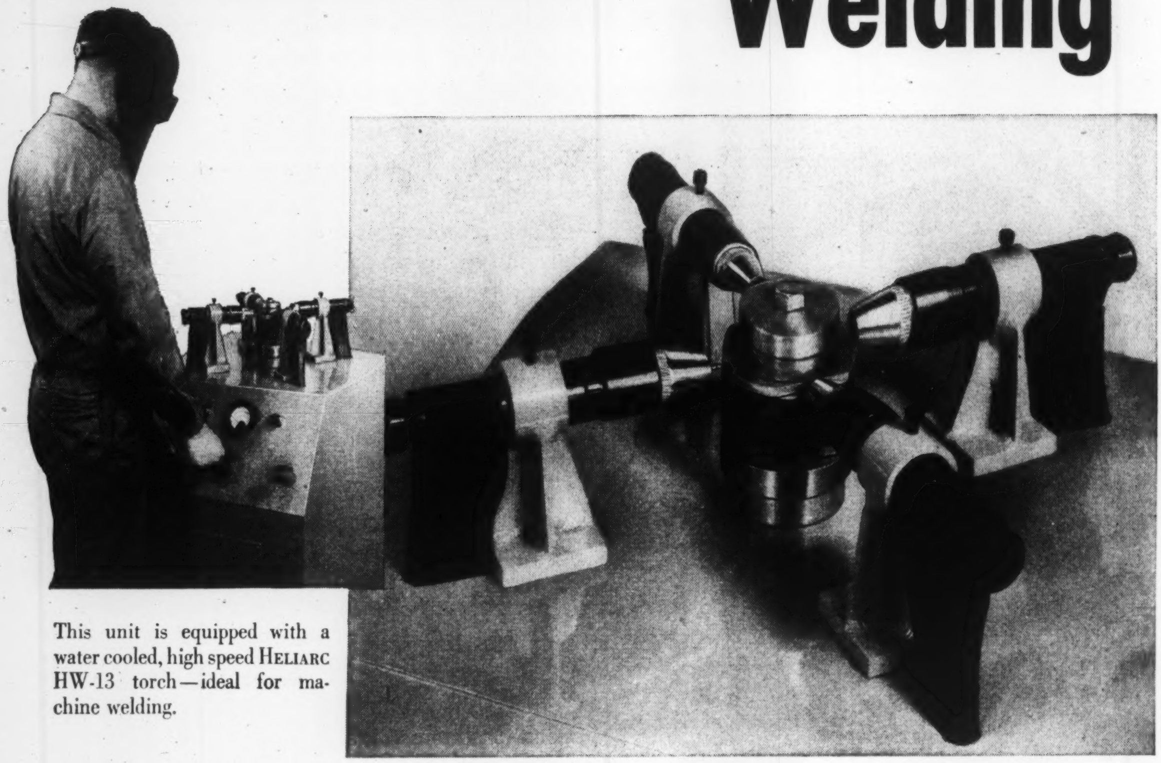
SAVE 50%

INCREASE PRODUCTION

with HELIARC

TRADE-MARK

Welding



This unit is equipped with a water cooled, high speed HELIARC HW-13 torch—ideal for machine welding.

Stator packs, thin sheet steel stampings joined together, form the laminated enclosure around the armature in electric motors. These parts have been riveted, bolted, and even welded together in the past...But now using HELIARC welding, they are produced faster and more economically than ever before.

Costs ½ a cent or less to HELIARC weld a stator which previously cost manufacturers one cent to rivet.

Maximum electrical efficiency is obtained with HELIARC welded stators—a quality difficult to obtain from riveted or bolted stators.

Welding speeds up to 60 in. per minute are now possible. HELIARC torches in a mechanized setup weld a complete stator pack in a matter of seconds.

HELIARC, sigma, and UNIONMELT welding processes—brought to industry by LINDE's service engineers, form a top notch fabricating team in operations for small shops or huge production lines. From carbon steel to complex alloys, whatever your welding needs are, your local LINDE representative will be glad to help you determine the most efficient, economical welding process for that work. Call him today for more information.

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A Division of Union Carbide and Carbon Corporation
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Division of Union Carbide Canada Limited, Toronto
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Linde
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The terms "Heliarc," "Unionmelt," and "Linde" are registered trade-marks of Union Carbide and Carbon Corporation.

—ITEM 583—

Design "Low Cost"

Into YOUR Equipment

GITS

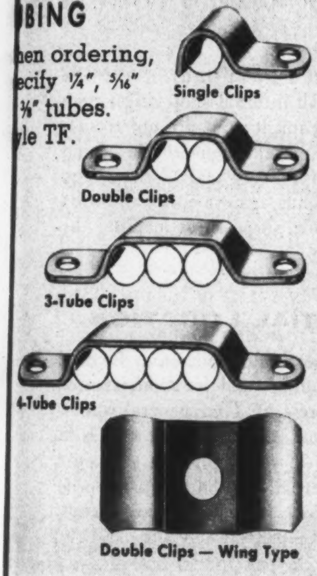
World's Largest Selection of
Low-Cost Lubricating Devices

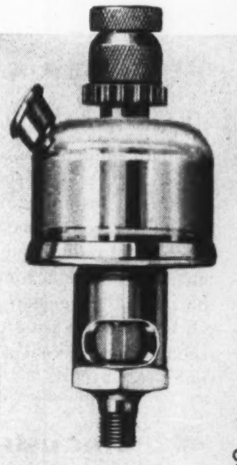
LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

Special Introductory Price
Just $14.95 F.O.B. Factory
Satisfaction or your money back

IPS FOR ATTACHING
BING

hen ordering, ecify ¼", 5/16" ⅜" tubes. le TF.

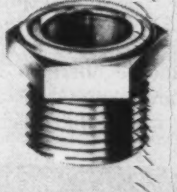




SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem.

Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.



GEAR CASE GAUGES

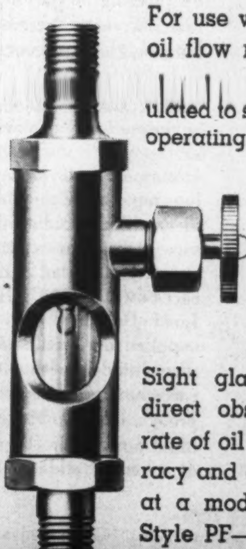
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.

SIGHT GRAVITY FEED MULTIPLE OILERS

is one unit replaces 3 to 8 dividual oilers. Maximum acticality in a small central brication system. Positive cut- during idle periods. Individ- l vibration-proof needle valve justments. With solenoid con- l (Illustrated): Style MDS—

SIGHT GAUGES

For use where rate of oil flow must be regulated to suit changing operating conditions.



Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere The items pictured above are only a few of our many thousands of lubricating devices. At the design stage get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

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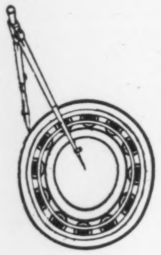
The Standard For Industry For Almost Half A Centu
1868-C South Kilbourn Avenue
Chicago 23, Illinois

Clip this page for handy "rough reference"

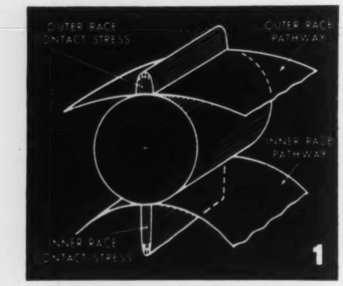
ONE OF A SERIES OF INFORMATIVE MESSAGES FROM HYATT...

Cylindrical Roller Bearing Outer Races



Why they are necessary . . . their importance in relation to bearing versatility . . . wide variety of configurations and locating devices

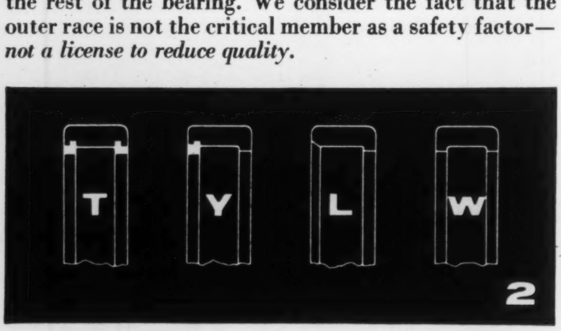
Outer races are necessary parts of all roller bearings, except in cases where a roller operating surface of suitable hardness and finish can be provided in the housing. In housings of aluminum, cast iron or unheat-treated steel where a hardened and ground surface cannot be obtained by any practical means, outer races are required to assure a fatigue-resistant pathway on which the rollers can operate smoothly.



1

The outer race is not normally the critical member of a cylindrical roller bearing. This does not mean, however, that outer races cannot suffer fatigue failure. All objects subjected to stress repetitions can fail after a small number of stresses—or may enjoy a surprisingly long life. But experience definitely shows that percentages favor the outer race, and the reason is apparent in Figure 1, which shows a roller engaging both an outer and inner race. Note that the load is spread over a larger area of contact on the outer race, which results in a much smaller maximum stress. This demonstrates in part the principal reason why inner races are the critical member of most cylindrical roller bearings, as explained in one of our previous messages.

Nevertheless, HYATT outer races are manufactured with the same scrupulous care that is applied to inner races and all other components of HYATT Bearings. Outer race performance must match the performance of the rest of the bearing. We consider the fact that the outer race is not the critical member as a safety factor—*not a license to reduce quality.*



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1. OUTER RACE TYPES

HYATT Hy-Load outer races are available in a variety of standard configurations for every type of application requirement (Figure 2). The W, L and Y races have solid flanges capable of sustaining light or intermittent thrust loads. The T and Y races are assembled with internal snap rings; they have equal radial load-carrying capacity but are not recommended for applications where a continuous thrust would be taken by the snap rings. The T, Y, L and W races may all be mounted using the roller ends against either the solid shoulder or internal snap ring for purposes of locating the outer race axially.

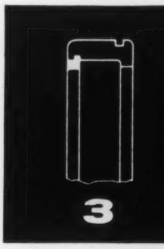
2. CIRCUMFERENTIAL LOCATION

An ample choice of outer race locating methods may be used with HYATT Hy-Loads. Circumferential location is often accomplished by the use of a press fit. (Our general recommendation is that the *rotating* race be applied with a press fit and the *stationary* race be applied with a push fit.) When a push fit is employed, circumferential location is satisfactorily accomplished by axial clamping against the race ends. *Positive* circumferential location is provided by the use of an outer race dowel.

3. AXIAL LOCATION

Axial location of an outer race is conventionally accomplished by pressing or pushing the race to a housing shoulder. The race may be constrained from "walking out" of the housing bore by the flange or snap ring operating against the roller ends. *Positive* axial location is accomplished by axial clamping against a housing shoulder or snap ring.

It may occur, however, that a shoulder is not available in the housing. Under these circumstances, it is necessary to employ an auxiliary holding device such as an external snap ring or an outer race dowel. HYATT Hy-Load Bearings can be supplied to original equipment builders with outer races having a snap ring groove (Figure 3) or a blind dowel hole (Figure 4) at small added cost.



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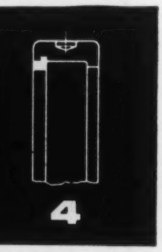

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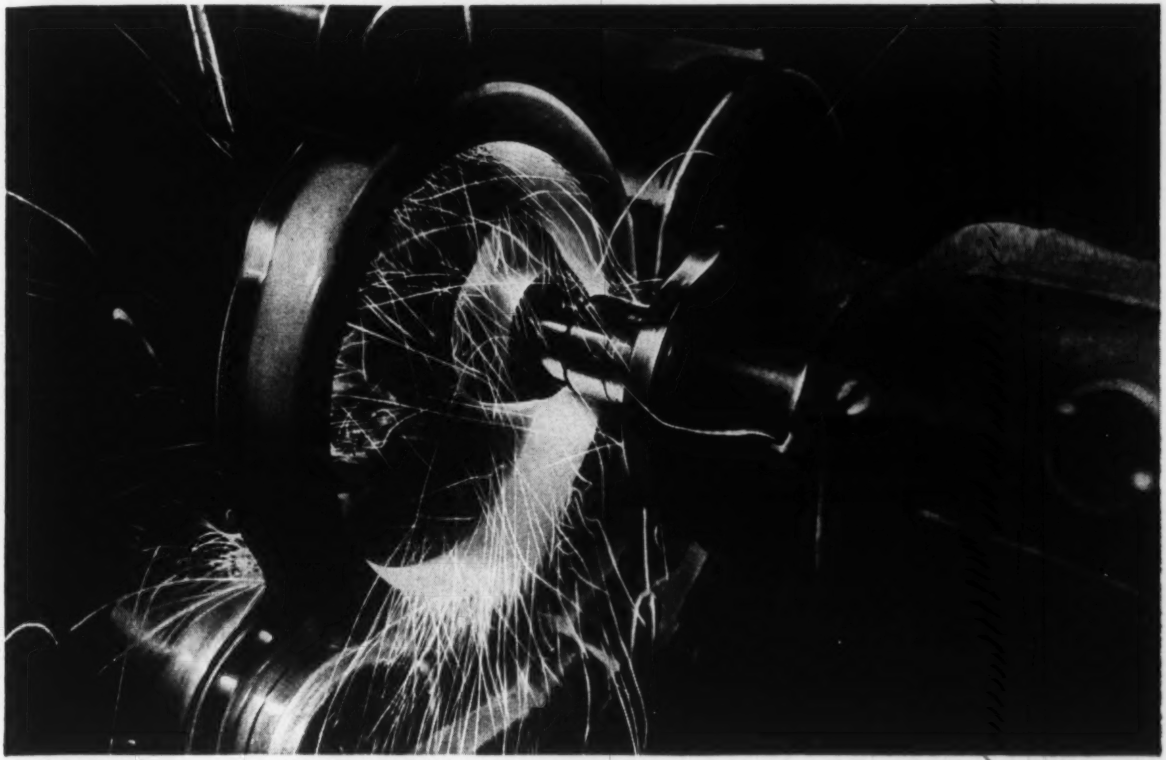


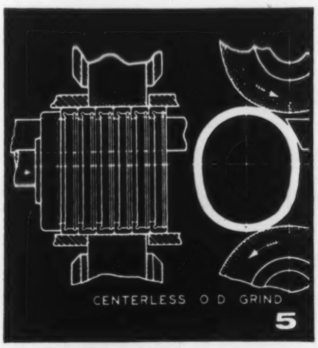
Grinding the flange on a Hyatt outer race.

4. OPERATIONAL REQUIREMENTS

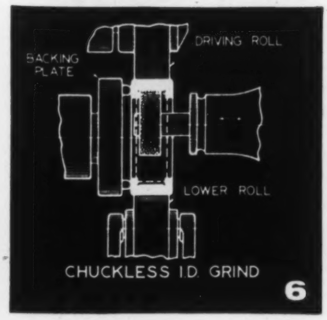
Since the outer race is usually the stationary member of the bearing, the exact maintenance of wall variations and runout is not ordinarily critical. However, the outer race *may* be the rotating race in certain applications—so quality controls are rigidly applied to all HYATT outer races to maintain:

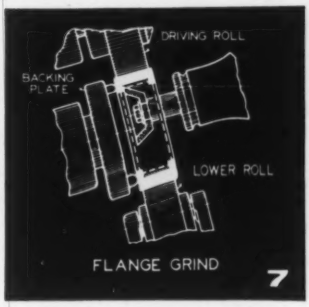
a. Minimum wall variation. **b.** Minimum runout of race ends to bore. **c.** Minimum runout of race flange inner faces to bore. **d.** Minimum pathway and outer diameter taper. **e.** Minimum outer diameter tolerance.

5. MANUFACTURING PROCEDURES



During manufacture, the following sequence of operations provide the controls necessary to generate outer races which meet the strict operational standards maintained by HYATT: After careful primary machining and heat treating, the ends are faced off square and parallel by a double end grind. This provides a reference surface from which all runouts and squareness can be gaged. Outer race diameters are generated by the centerless grinding method to provide an O.D. with as little out-of-round as practical. The through-feed method of grinding represents a valuable economy (Figure 5) to help reduce race costs.





Next, the pathway (or race I.D.) is ground centerless, generating a cylinder concentric with the O.D. cylinder. This is accomplished by driving the race on the O.D. and positioning the grinding wheel relative to the drive roll (Figure 6). Finally, the flanges are ground using the race ends as a reference. The result is a race of as nearly perfect geometry as is practical (Figure 7). It is then critically inspected to insure traditional HYATT dependability and the maximum possible service life.

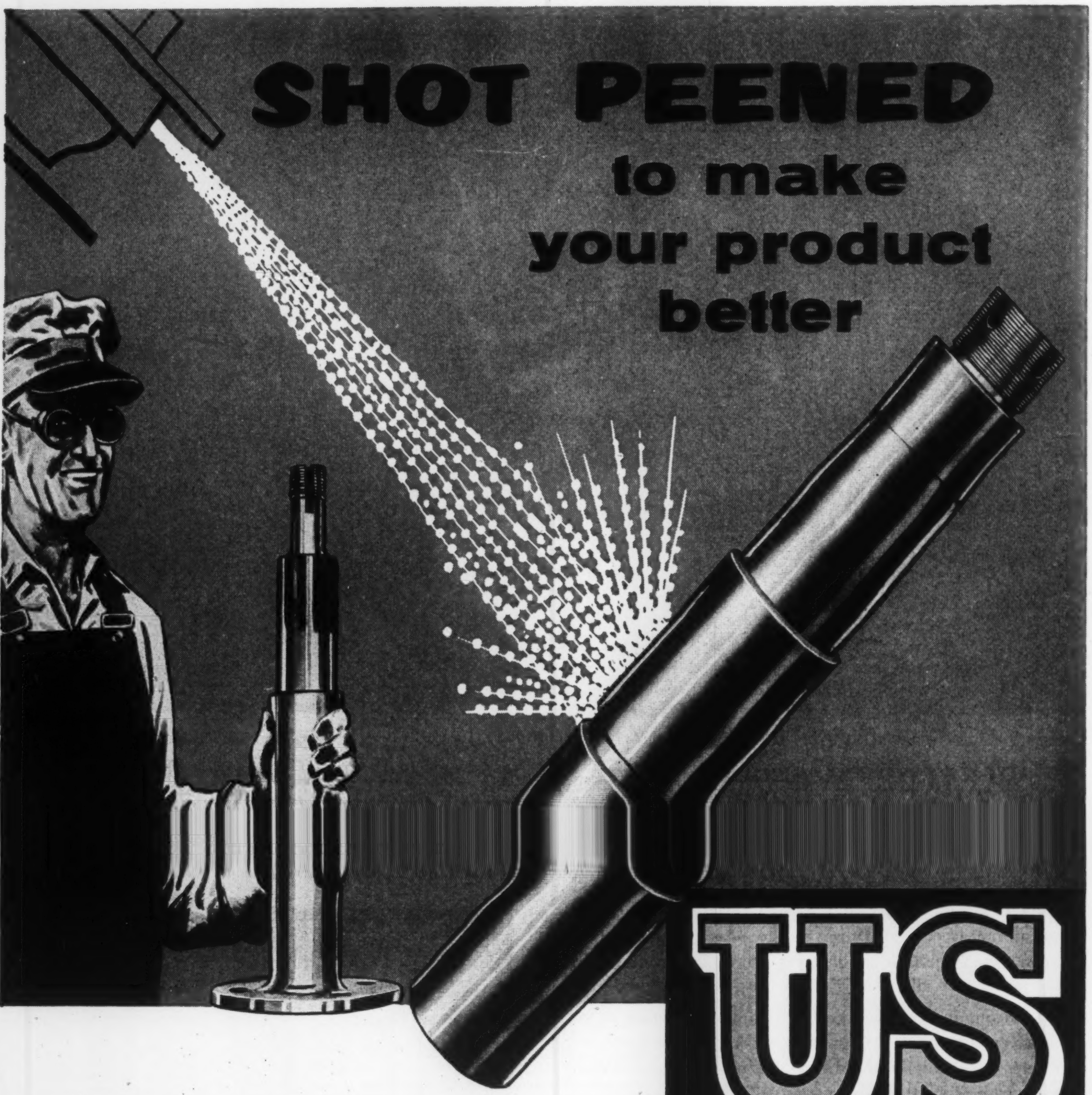
YOU WILL FIND FURTHER DETAILS

in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type of cylindrical roller bearings best suited to your design requirements. Remember, HYATT is America's *first* and *foremost* maker of roller bearings. Hyatt Bearings Division of General Motors, Harrison, N. J.

GM
GENERAL MOTORS

HYATT
ROLLER BEARINGS

—ITEM 585—
For More Information Circle Item Number on Yellow Card—page 19



SHOT PEENED

to make your product better

US

U. S. AXLE has long been famous for custom-made precision shafts, machined from finest alloy steels. Now, with the addition of new shot peening equipment, U. S. "Custom-Engineered" Shafts can be *made up to 5 times tougher*, for extra advantages in every type of product.

LIGHTER WEIGHT
Extra strength permits using shafts of smaller diameter, reducing weight.

LONGER LIFE
In actual torsion tests, U. S. shot peened shafts outlasted unpeened shafts approximately 5 to 1!

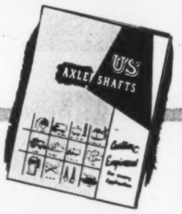
"THE WORLD TURNS ON U. S. AXLES"

THE US AXLE COMPANY, INC.
Since 1920 • Pottstown, Pennsylvania

"Custom-Engineered"

AXLE SHAFTS

for every application



This illustrated folder will show you why U. S. AXLE is your best source for precision-made special shafts. Write for your copy today.

For a prompt quotation on a U. S. "Custom-Engineered" Shaft, to meet your needs, send us your blueprints and specifications.

—ITEM 586—
For More Information Circle Item Number on Yellow Card—page 19

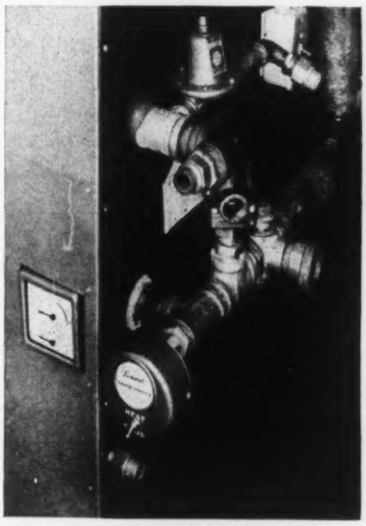
(Advertisement)

How to Control a Home Air Conditioner

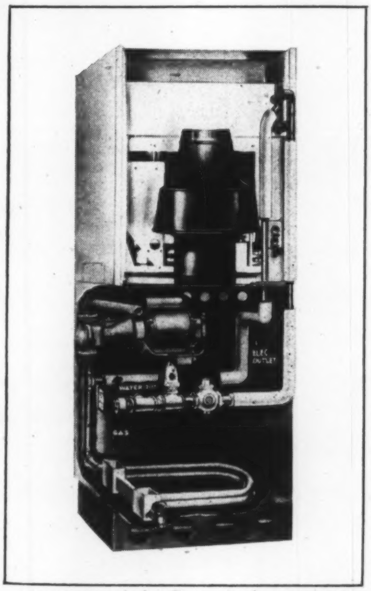
No. 2 of a series — *Showing the broad application range of Fenwal Controls*

In this packaged high efficiency home heating and cooling system, a gas boiler and a water chiller combine to raise or lower the temperature of water circulating to the room conditioner units. The problem was to regulate the temperature of the water precisely, by supplying or removing just enough heat, so that the desired room temperature would be assured.

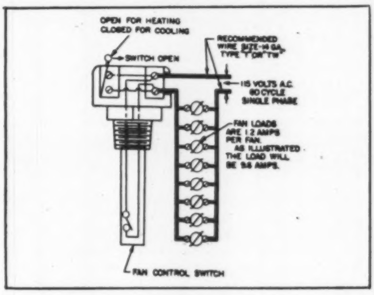
The solution was a Fenwal Snap-Action THERMOSWITCH control, Series 20000. Temperature range of this particular model is 25° to 225°, and the setting is at 100° ± 3°F. The device functions as a low limit common fan control for all unit room conditioners. In the heating operation it permits fans to operate when the boiler water temperature reaches 100°F, shuts them off when water temperature drops below 100°F. In the cooling operation the cover-mounted toggle switch permits continuous fan operation and acts as an off-on switch for all room unit fans.



A FENWAL SNAP-ACTION THERMOSWITCH® UNIT in this home air conditioner effectively controls both heating and cooling operations. This type of Fenwal device is ideal where a local bulb unit is required for accurate control with relatively large electrical loads.

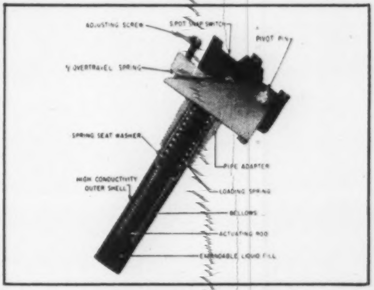

ELEC OUTLET
WATER OUT
GAS

LOCATION of the Snap-Action THERMOSWITCH control in the air conditioner is at the boiler outlet, between the outlet and the pressure relief valve at the system supply outlet. This cut-away view shows its position relative to other elements in the system's central unit.


OPEN FOR HEATING
CLOSED FOR COOLING
SWITCH OPEN
RECOMMENDED WIRE SIZE-14 GA. TYPE "T" OR "TW"
115 VOLTS A.C. 60 CYCLE SINGLE PHASE
FAN LOADS ARE 1.2 AMPS PER FAN. AS ILLUSTRATED THE LOAD WILL BE 9.6 AMPS.
FAN CONTROL SWITCH

FANS ARE CONTROLLED by the Snap-Action THERMOSWITCH unit as shown in this wiring diagram. Note the toggle switch (top), manually operated for heating or cooling, the thermostatically operated fan control switch (bottom), and the individual fan connections (right).

OPERATING PRINCIPLE. In the Fenwal Snap-Action THERMOSWITCH control, Series 20000 and 21000, contacts in the head are actuated by a push-rod connected to a bellows in the liquid-filled shell. High thermal activity, necessary to combine close control with "snap" contact actuation, is achieved by converting the cubical expansion of the liquid to linear motion of the push-rod at the snap switch. Since the liquid completely surrounds the bellows and is in direct contact with the external shell, fast response is assured. Units are available in six standard temperature ranges between −75°F and +300°F. Units are UL approved.


ADJUSTING SCREW
S.P.D.T. SNAP SWITCH
PIVOT PIN
½ OVERTRAVEL SPRING
SPRING SEAT WASHER
PIPE ADAPTER
HIGH CONDUCTIVITY OUTER SHELL
LOADING SPRING
BELLOWS
ACTUATING ROD
EXPANDABLE LIQUID FILL

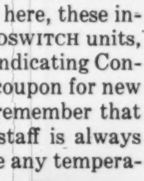
Many Other Uses

Among the growing list of applications for Fenwal Snap-Action THERMOSWITCH controls are: hot drink vending machines, commercial laundry equipment, commercial dishwashers and swimming pool heaters. Wherever accurate, sensitive temperature control under high electrical loads is required, the Series 20000 and 21000 units offer advantages found in no other thermostatic controls.

For Your Own Applications

Investigate the many different types of Fenwal temperature control and detection devices. Besides the 20000 Series described here, these include standard THERMOSWITCH units, Midgets, Miniatures, Indicating Controllers, etc. Send the coupon for new Catalog No. 500 and remember that Fenwal's engineering staff is always ready to help you solve any temperature control problem.

FENWAL INCORPORATED
195 Pleasant Street
Ashland, Mass.



Please send me your Catalog No. 500. Our specific problem is:..........................

....

....

Name.................. *Title*..........

Address......................................

City.......... *Zone*..... *State*.......

Fenwal CONTROLS TEMPERATURES . . . *PRECISELY*

—ITEM 587—
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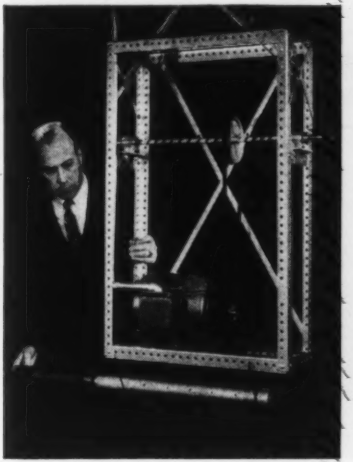
XUM



TOMORROW:

A standard motor that can survive infinite heat

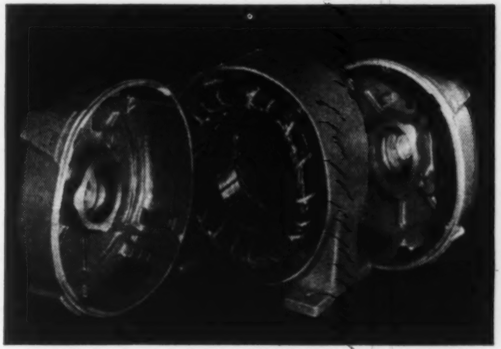
The new Life-Line A is another step closer

Westinghouse is working on tomorrow's motor today. Investigating new materials—testing existing motor designs.

No standard motor today can survive the ultimate test shown here. But we do know that the new Life-Line® "A" can operate under higher temperatures than ever before. It has stronger insulation and better bearing protection than any other motor on the market. It's industry's closest approach to a standard motor that is absolutely heatproof.

Your Westinghouse sales engineer can show you many additional reasons why the Life-Line "A" is industry's most advanced and preferred motor. Call him today.

J-21926

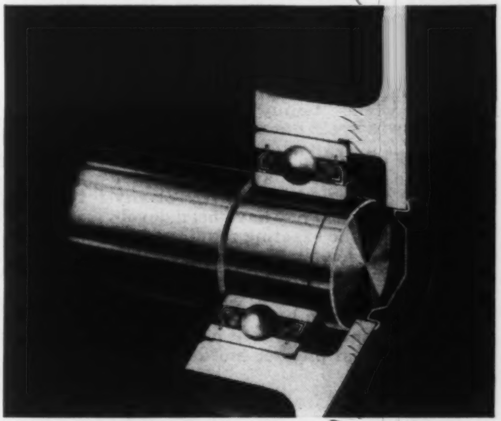


New fortified insulation includes exclusive Bondar, Bondite and Mylar*—three good reasons why the Life-Line "A" is so resistant to heat or any other motor contamination.

*DuPont Registered Trade-Mark

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

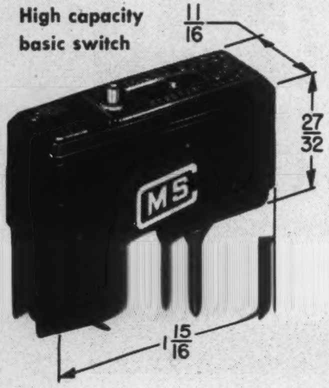


Two outer seals of new 4-way sealed bearing act as flingers and literally throw off damaging contaminations. Inner seals, attached to outer bearing race, are stationary and form a positive labyrinth.

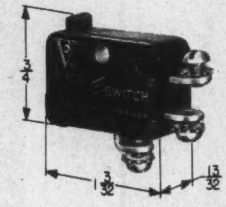
—ITEM 588—

MICRO *precision switches*

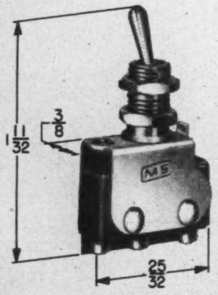
...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



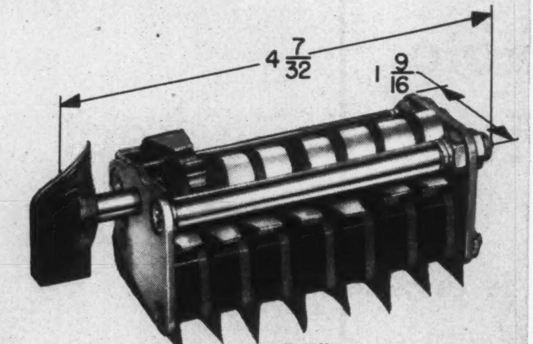
High capacity basic switch



Type "V3" switch



Subminiature toggle switch



"V3" rotary selector assembly

A continuous flow of Precision Switch developments anticipates designer's needs

Whatever the design requirement—whether it calls for unusually small size, unusually high electrical capacity or unusual actuation and circuit arrangement—there is a MICRO precision switch to meet it. That is why designers have long made it standard policy to check with MICRO SWITCH as new needs develop.

Shown here are just a few small, compact switch designs that are typical of MICRO SWITCH development. Each is one of a whole "family" of extremely reliable switches.

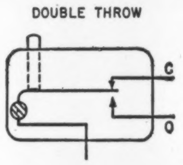
Type "V3" Switch. The MICRO SWITCH "V3" line switches have the highest electrical capacity for their size of any switch available. They have been developed to meet the exacting requirements of designers for an extremely small, compact switch without sacrifice of quality. Actuators are available to permit their actuation by cams, slides and other mechanical motion not in line with the switch plunger motion. (Send for catalog 74).

"V3" Rotary Selector Assembly. These assemblies are available with from one to eight switching units and from two to eight detent positions. Light in weight and small in size, these assemblies are well suited for use in electronic and aircraft applications. Many assemblies are available with various camming sequences. (Send for catalog 74).

High Capacity Basic Switch. This switch combines high electrical rating with high inrush capacity. The steady state current rating is 20 amperes, with inrush capacity of 75 amperes on voltages up to 460 volts a-c. These switches are especially useful for handling high inrush currents of solenoids, motors and tungsten lamps. (Send for catalog 62).

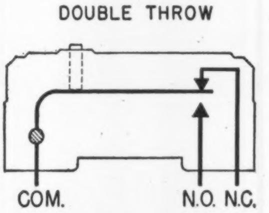
Subminiature Toggle Switch. This is one of a number of subminiature toggle switch designs developed for subminiature assemblies. The toggle switch illustrated consists of one MICRO subminiature switch riveted into the stainless steel toggle bracket. The assembly is for single-pole, double-throw service. Double-throw switches can be used "normally open" or "normally closed" by wiring to either the normally open or normally closed terminals. (Send for catalog 75).

Circuit Arrangements



Type V3 Switch

This switch has a single-pole, double-throw contact arrangement. Electrical rating is: 10 amperes, 125 or 250 volts a-c; ½ ampere, 125 volts d-c; ¼ ampere, 250 volts d-c.

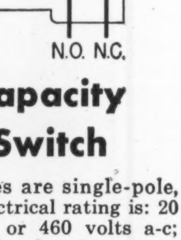


High Capacity Basic Switch

Standard switches are single-pole, double-throw. Electrical rating is: 20 amperes 125, 250 or 460 volts a-c; ½ ampere 125 volts d-c; ¼ ampere 250 volts d-c; 1 H. P. 115 volts a-c; 2 H. P. 230 volts a-c; 10 amperes 125 volts when controlling tungsten filament lamp loads on a-c circuits.

Subminiature Toggle Switch

Contact arrangement is single-pole, double-throw. Double-pole, double-throw assembly, using two subminiature switches is available. Electrical rating is: 5 amperes 125 or 250 volts a-c. The 30 volt d-c rating is, inductive —3 amperes at sea level and 2.5 amperes at 50,000 feet, resistive—4 amperes at sea level and 4 amperes at 50,000 feet, maximum inrush is 15 amperes.



MICRO SWITCH *Engineering Service, experienced in precision switching problems, is available—at the* MICRO SWITCH *branch nearest you. Why not call today?*

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

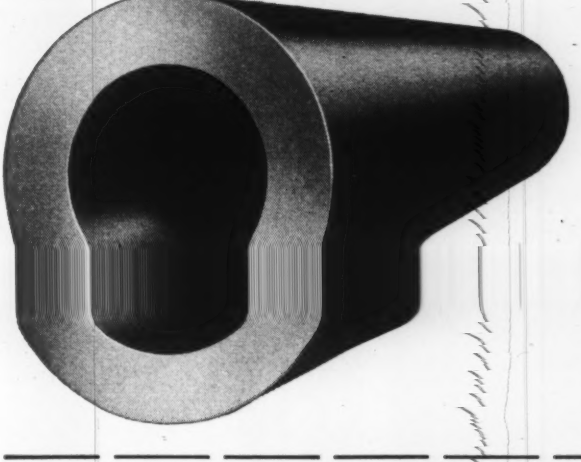
In Canada, Leaside, Toronto 17, Ontario • **FREEPORT, ILLINOIS**

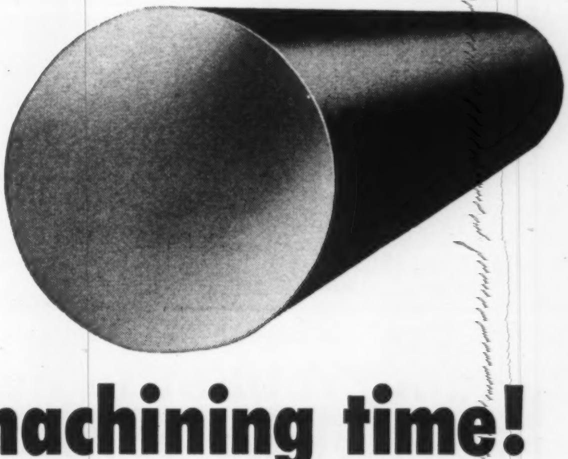
—ITEM 589—

For More Information Circle Item Number on Yellow Card—page 19

When you make hollow parts...

Start with seamless tubing





instead of bar stock

Save steel, machining time!

WHEN you make hollow parts from bar stock, you waste time boring the center hole—you waste steel because you have to throw away the chips you bore out. Why not do it the easy, economical way? Start with Timken® seamless tubing. The hole's already there! Finish boring is often the first production step. You cut machining time—get more parts per ton of steel.

With Timken seamless tubing, your machine tools are more productive. Screw machine stations normally used for drilling can be released for other jobs. You get added machine capacity without additional machines.

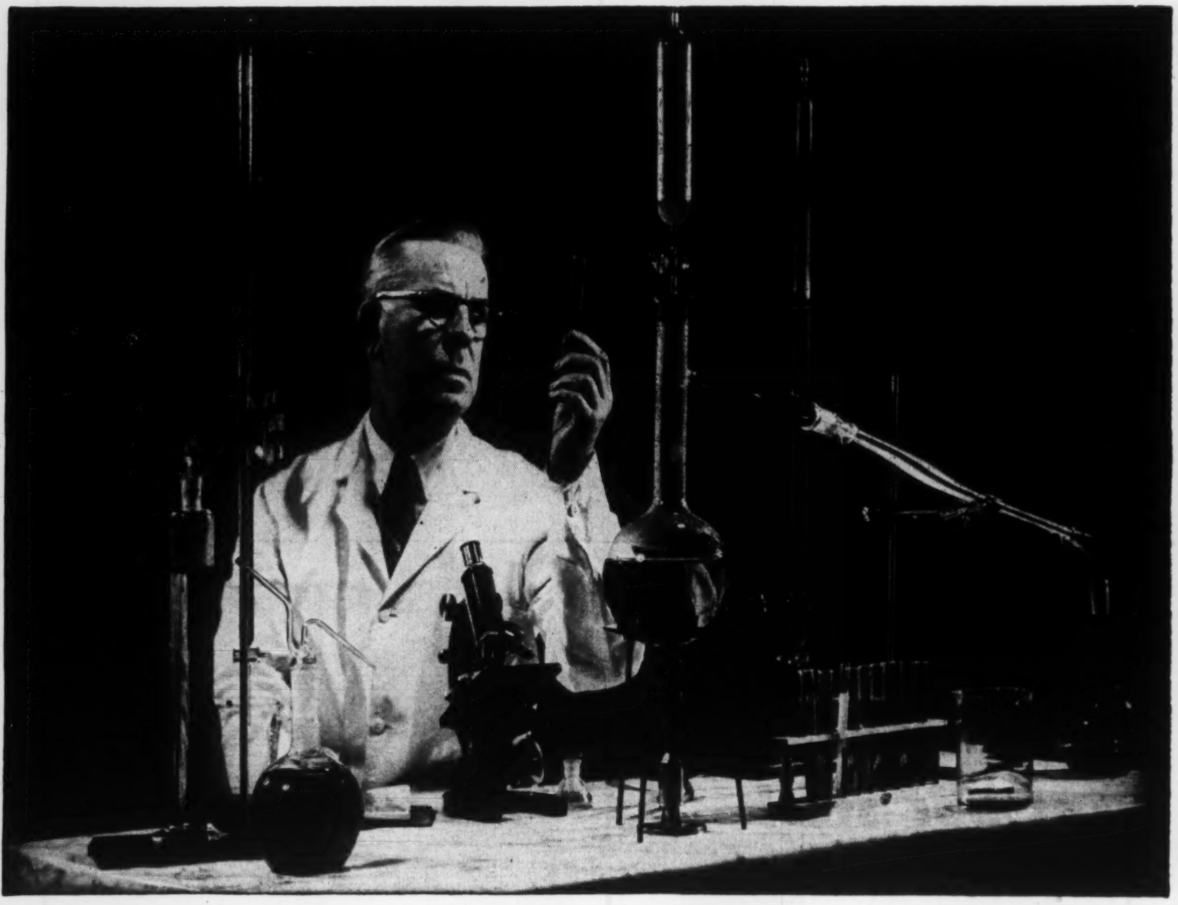
To make sure you save even *more* steel, our engineers will study your problem and recommend the most economical tube size for your hollow parts job, guaranteed to clean up to finish dimensions.

You also get the highest internal quality with Timken seamless tubing. The piercing process by which it's made is basically a forging process. Result: a uniform spiral grain flow for greater strength and a refined grain structure which brings out the best quality of the metal. And the Timken Company's rigid control keeps the quality uniform from tube to tube and heat to heat. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

TIMKEN
Fine Alloy
STEEL

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



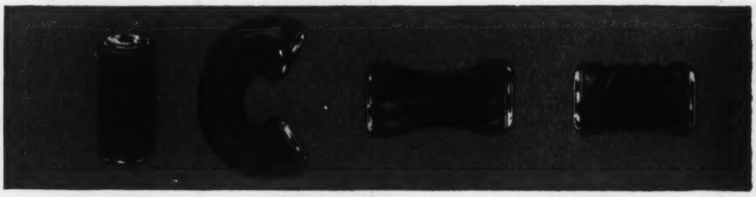
Bonding rubber to nylon is one of PHOENIX' specialties

We are unusually successful at bonding natural and synthetic rubber to nylon. For example, with the flexible coupling shown below, the rubber will actually rupture before bond failure.

When you work with PHOENIX you have twenty years' experience in developmental work at your disposal. Quality control is of the utmost importance at PHOENIX. Modern laboratory facilities and exacting production control methods assure the closest of tolerances.

It is PHOENIX' practice to work in strictest confidence with our customers. Whatever rubber molding problems you may have, call on us. We are here to serve you.

Please address all inquiries to Rubber Products Division.



PUTTING THIS FLEXIBLE RUBBER-NYLON COUPLING THROUGH THE PACES. TESTING ITS "BEND," TENSILE STRENGTH AND TORQUE.

PHOENIX should be your source for custom rubber molding

PHOENIX MANUFACTURING COMPANY

RUBBER PRODUCTS DIVISION **JOLIET, ILLINOIS**

NEW!

LAMINATED SHIMS of Aluminum

You can now get all the advantages of aluminum—light weight, non-corrosion and freedom from electrolytic action—in both LAMINUM® and LAMISOL.®

In LAMINUM® the .003" laminations are held together by a microscopic binder over their *entire* surfaces. LAMISOL® Shims are tack-bonded at the *edges only.*

Both types of aluminum Laminated Shims look and function like solid shims. Yet they p-e-e-l quickly and easily for fast, accurate assembly. No counting of loose layers. No stacking. No miking. You save in machining and finishing, in maintenance adjustments, too.

For full information, and a sample of an actual Laminated Shim of aluminum, use the coupon below.

they look "solid" yet p-e-e-l for adjustment

Aluminum Shim laminations are 2-S-H-19 .003" foil conforming to U. S. Spec. QQ-A-561. Also available as part solid, part laminated Shims in accordance with Boeing Process Spec. Boeing Standard BAC-5430 and BAC-1524.

100 UNION STREET, GLENBROOK, CONN.

Gentlemen:

Please send me, without obligation, an actual aluminum Laminated Shim and your interesting free booklet telling all about laminated shims and how they're used to cut costs.

SHIM
HEADQUARTERS
SINCE 1913
for
Brass, Steel
(and now Aluminum)

NAME______________________________

USE PENCIL OR BALL POINT PEN

COMPANY____________________________

ADDRESS____________________________

CITY____________________STATE__________

Here's the Complete "Package"
for Counting Electrically...
156872
Veeder-Root Inc. Hartford, Conn.

Added Evidence that —

Everyone Can Count on

VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter (AC or DC) is actuated through electromagnets. And it may be connected in series with any device having a contact arrangement . . . like the specially designed Veeder-Root Electrical Contactor at the left, which insures positive operation of the counter, either in oscillation or connected directly to a revolving shaft . . . with the counter placed at *any* distance from the machine or process on which the count is required.

This is another one of the hundreds of Veeder-Root Standard and Special Counting and Computing Devices developed for every conceivable counting duty, in every field from atomics to electronics.

What do *you* need to count? Just write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada •
Offices and Agents in Principal Cities
"The Name that Counts"

—ITEM 593—

For More Information Circle Item Number on Yellow Card—page 19

ORTMAN-MILLER

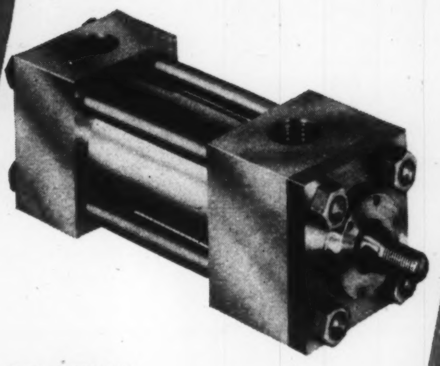
Cylinders

- Air and Hydraulic
- Meet JIC Standards

O-M Tie-Rodless (air-hydraulic) with compact space-saving design, due to O-M Special Interlocking Mechanism, eliminates bulk . . . saves up to ⅓ installation space. Interlocking feature also makes it easy to orient ports, disassemble, inspect, clean, repair, assemble, thus reducing maintenance.

Available in complete range of sizes (1½" to 8" bores), with standard 2 to 1 or oversize rods. All steel construction with bearing bronze. Completely interchangeable parts and mounts, described in Bulletin 101A.

O-M TIE-RODLESS
Air to 500 psi
Hydraulic to 1500 psi



O-M SERIES TH
Hydraulic 2000 psi

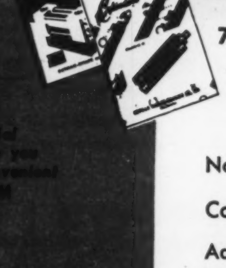
O-M Series TH (heavy duty hydraulic) rated at 2000 psi—features heavy walled seamless steel tubing, microhoned for minimum friction, and rolled steel heads accurately machined and recessed to confine the tube, prevent breathing and to provide additional protection against leakage under most severe usage. Hard chrome plated piston rods. A multiple lip self-compensating rod gland packing, contained in a removable cylinder, facilitates replacement without disassembling cylinder.

Available from 1½" to 8" bores described in Bulletin 105.

Mail coupon today for Bulletins 101A and 105

Engineering Service—

Consult an Ortman-Miller representative regarding your pneumatic and hydraulic problems. His broad experience with standard and special cylinder applications is available to you without cost or obligation. Use convenient coupon for name and address of O-M representative nearest you.



ORTMAN-MILLER MACHINE COMPANY

7 143rd Street, Hammond, Indiana

☐ Have representative call
☐ Send Bulletins 101A and 105

Name____________________ Position__________

Company________________________________

Address_________________________________

City__________________ Zone_____ State____________

—ITEM 594—
For More Information Circle Item Number on Yellow Card—page 19

MUELLER BRASS CO.

improves LENSOMETER

lower cost

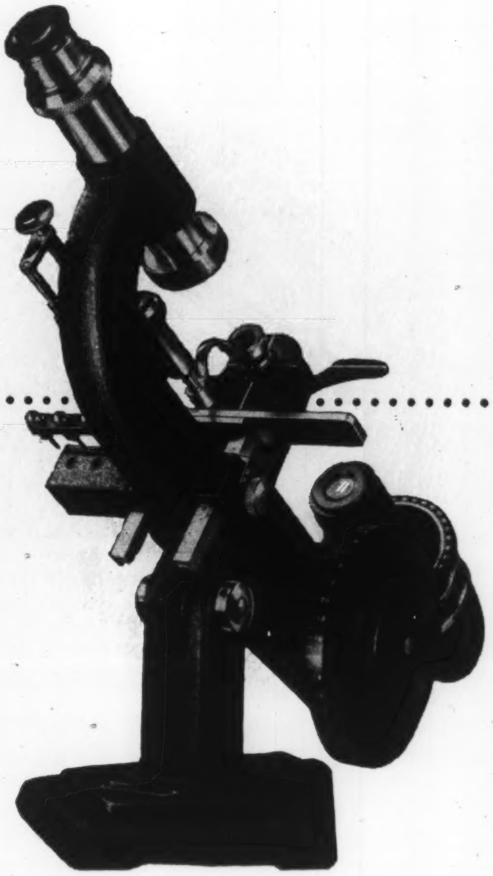
FORGED PART APPROXIMATELY ½ SIZE

Precision and extreme accuracy are vitally important functions of the Lensometer, manufactured by the Instrument Division of the American Optical Company, Buffalo, N. Y. The Lensometer is used to determine the focal strength and axis of an optical lens and, consequently, must be extremely precise in operation to provide accuracy and uniformity in lens prescriptions.

Forgings made by the Mueller Brass Co. play an important role in the construction of the Lensometer and contribute to its outstanding performance. Formerly, the body of the Lensometer was produced from *three* sand castings, but these now have been replaced by just *two* forgings. Naturally, this simplifies assembly, and the big forged bronze main support arm, shown above, along with the lens support bracket insures the constantly accurate alignment of the instrument. During the first year when forgings were used instead of castings, American Optical not only recovered the initial tooling costs but also realized considerable savings on each Lensometer produced. This is another good example of the way Mueller Brass Co. forgings can benefit a product two ways . . . better performance and lower costs. Chances are, your product can likewise be improved at a savings to you if you specify brass, bronze or aluminum forgings made by the Mueller Brass Co.

O. FORGING

R at substantially



METALS AND ALLOYS REVIEW

by FRANK M. LEVY

Vice-President and Director of Research

One of our most interesting series of alloys is the group which we market under the tradename "Tuf-Stuf" . . . a group of aluminum bronze alloys with range and flexibility to meet the most demanding needs. They are high copper base alloys containing from 9% to 13% aluminum and varying amounts of iron, nickel and manganese. Being free of zinc, they are not subject to dezincification. Tuf-Stuf alloys have a low coefficient of friction, good wearing qualities, high tensile strength, high hardness and the ability to withstand heavy pounding. Some of the alloys can be hardened by heat treatment. In the harder grades, these alloys are used for heavy duty service where high compressive loads are encountered and where lubrication may be scant. Present day increases in operating speed of modern machine equipment and the economy of little or no machine "down" time has made Tuf-Stuf popular in the machine tool industry. It is used in a multitude of applications where resistance to wear is important, such as: Drill Jigs, Feed Nuts, Rollers, Cams, Collets, Gibs, Gears, Boring Bar Guides, Lead Screw Nuts and Clutch Shifter Forks. Also, because of their ability to withstand higher stresses and resist season-cracking, these alloys are ideally suited for threaded nuts and bolts and pole-line hardware.

The unusual physical properties of the Tuf-Stuf series have made it particularly useful in the chemical and allied industries. These alloys combine the strength and ductility of medium steel with high resistance to corrosion by many chemicals. Tuf-Stuf alloys will not only resist oxidation at elevated temperatures, but will also retain a greater portion of their strength and hardness at these temperatures than will the copper zinc alloys. These properties make them ideal in the aircraft industry for valve seat inserts, spark plug bushings, valve guides and propeller hub cones.

Tuf-Stuf alloys are supplied as forgings, rod or screw machine products. As forgings the grain structure can be controlled to produce parts that are strongest at points of greatest stress and strain. Relatively intricate shapes can be forged to closer tolerances than sand castings. Where appearance is a factor, a forging may easily prove more economical since a minimum amount of machining, buffing or polishing is required before finishing.

If you'd like more information about this series of alloys, drop me a line or better yet, send me your sample part or blueprint and an explanation of its use and we'll be glad to submit our recommendations.

forgings
• brass
• bronze
• aluminum

• WRITE TODAY FOR THE ENGINEERING MANUAL YOU NEED

Mueller Brass Co. Forgings Engineering Manual H-58565 ☐

Tuf-Stuf Aluminum Bronze Alloys Engineering Manual H-58563 ☐

600 Series Bearing Alloys Engineering Manual FM-3000 ☐

Copper Base Alloys in Rod Form Engineering Manual FM-3010 ☐

MUELLER BRASS CO.

PORT HURON 15, MICHIGAN

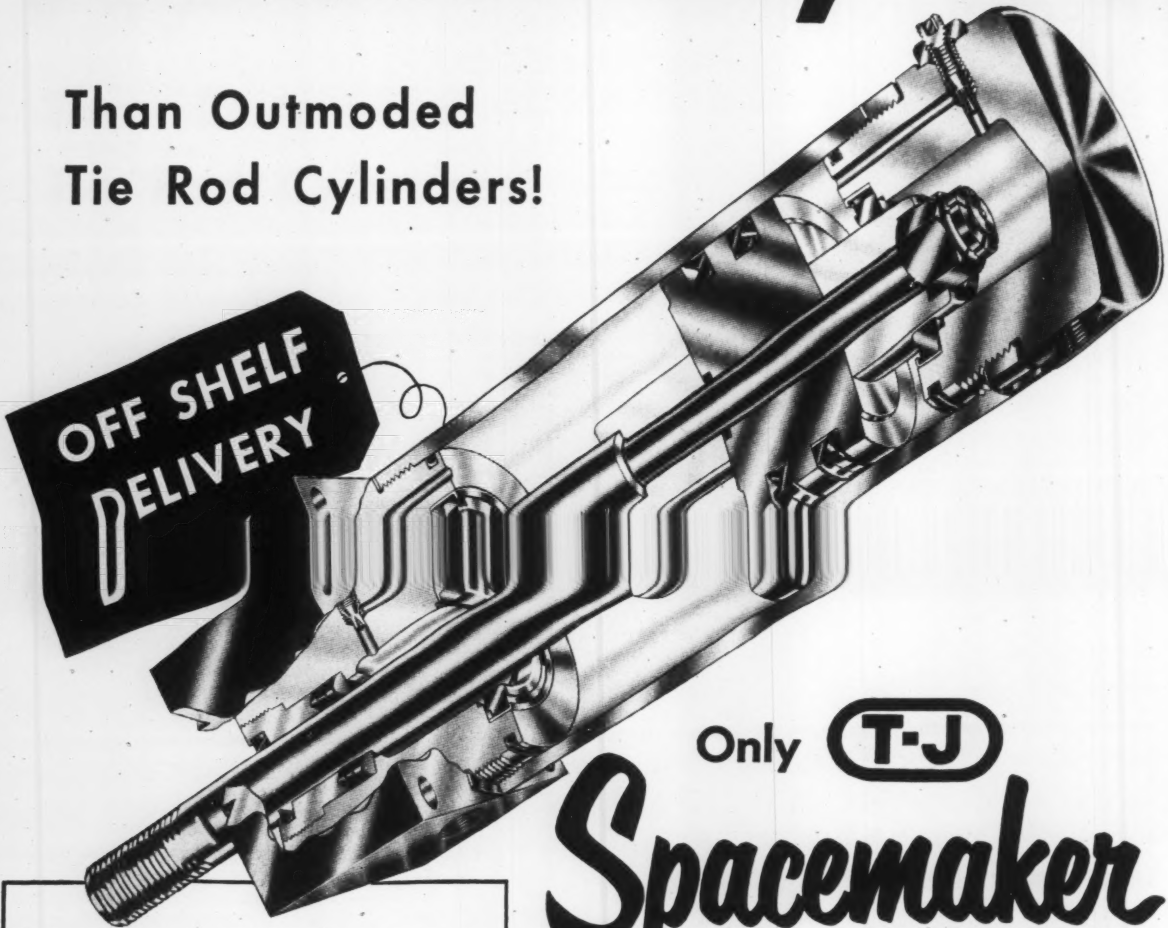
178

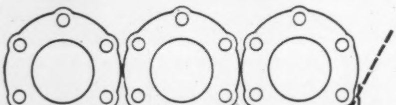
—ITEM 595—
For More Information Circle Item Number on Yellow Card—page 19

Saves 40% Space!

STRONGER, TOO

Than Outmoded Tie Rod Cylinders!





T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

NEW LITERATURE . . . send today for new Bulletin with complete details of Spacemaker line.

Only T-J Spacemaker CYLINDERS

Offer All The Extras As Standard!

- NEW *exclusive* Ingenious Cushion Designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Compact design eliminates tie rods, saves up to 40% space
- Proven Performance . . . with Extra High Safety Factor
- Hard Chrome Plated Bodies and Piston Rods (Standard, at no extra cost).
- OIL pressure to 750—AIR to 200 P.S.I.

You'll find many answers to *automation* in your plant with T-J Spacemaker Cylinders! Designed with years-ahead features for top performance and dependability. Wide range of styles, capacities . . . for all kinds of push-pull-lift operations . . . reduces man-hours and costs! Write The Tomkins-Johnson Co., Jackson, Michigan.

MEMBER OF THE NATIONAL FLUID POWER ASSOCIATION

T-J TOMKINS-JOHNSON

RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

DU PONT ELASTOMERS

NEOPRENE – HYPALON

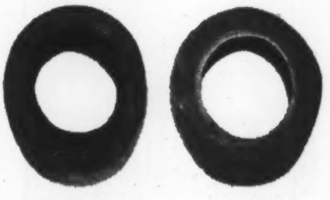
in Design

DU PONT HYPALON®
extends the boundaries of design for elastomeric materials

Resilient Products made of HYPALON, for use under severe service conditions, offer you new materials for design. Among the many outstanding advantages of HYPALON is its resistance to oxidizing chemicals. Here is a partial listing of chemicals which have little or no effect on HYPALON compositions:

Chemical	Concentration	Maximum Temperature
Chromic Acid	50%	200°F.
Nitric Acid	20%	158°F.
Phosphoric Acid	85%	200°F.
Sodium Hypochlorite	20%	200°F.
Sulfuric Acid	95.5%	70°F.
Pickling Solution (20% Nitric Acid, 4% Hydrofluoric Acid)		158°F.

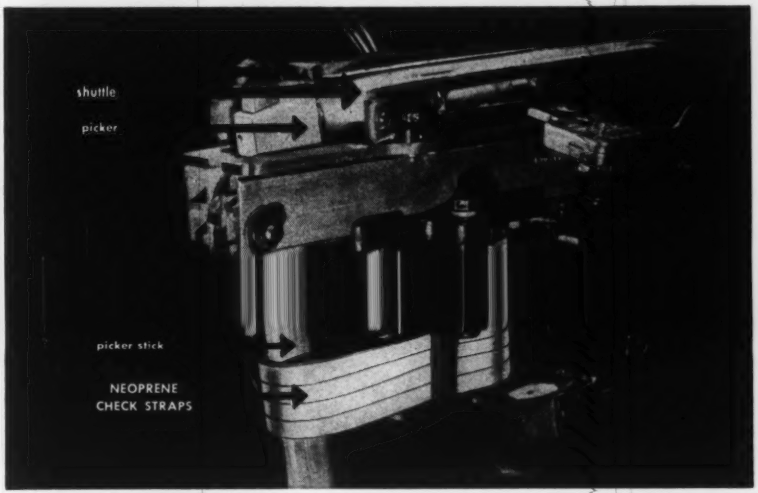
In addition to chemical resistance, HYPALON products are resistant to other severe conditions such as heat, ozone and weathering. HYPALON can be used in applications where temperatures range from 250°F. to 350°F. It is unaffected by ozone. It can be compounded in a complete range of lightfast, weather-resistant colors. So, when your designs anticipate severe service, consider HYPALON. Mail the coupon today for further information.



Natural Rubber HYPALON

Two tubing samples were filled with 98% (66°Be.) sulfuric acid for 24 hours at room temperature. Rubber deteriorated rapidly. HYPALON remained undamaged.

Newly designed NEOPRENE check straps outlast leather 3 to 1 on new high-speed textile looms



Neoprene's flex life, heat resistance reduce replacements, eliminate adjustments

A recent improvement in check-strap design promises to save the textile industry upwards of $3,000,000 annually. From the designer's viewpoint, this success is due to an imaginative approach—designing a three- or four-piece neoprene strap to replace a conventional one-piece leather strap.

This is the story. On high-speed looms the shuttle is hurled back and forth across the loom face at the rate of 200 times a minute. Every time the picker (see photo) throws or catches the shuttle, the picker stick slams into the check strap and stops. The combination of flexing, heat buildup and high weaving-room humidity made several adjustments of one-piece leather straps necessary to compensate for stretching, and limited their service life to 6 to 8 weeks. Many kinds of leather straps were tried, but leather still tended to distort, elongate, become fleshy and break.

The first and most important need was a check strap that wouldn't stretch. This was accomplished by plies of woven fabric and tire cord. But these strength-giving members had to be firmly bonded into a homogeneous strap in order to operate properly. Naturally neoprene was chosen as the best possible binder, because it had good adhesion to the fabric, was resilient and flex-resistant, and retained these properties in spite of heat and splash oil.

Performance confirms choice

And service confirmed the soundness of the manufacturer's choice of materials. The new straps lasted 3 times longer than the best leather, and stretch adjustments were completely eliminated.

You, too, can solve design problems by using neoprene products. For further information on designing new or improved products with neoprene, clip and mail the coupon below.

DU PONT
REG. U. S. PAT. OFF.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Please send further literature and add my name to the mailing list for your free publications, the "Neoprene Notebook" and "Facts about HYPALON®," which show how the Du Pont elastomers are used in designing new products, improving old.

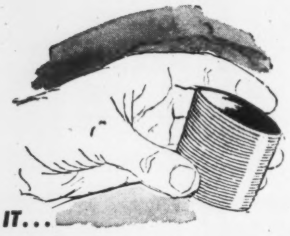
E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division, Dept. MD-5
Wilmington 98, Delaware

Name________________ **Position**________
Firm________________
Address________________
City________________ **State**________

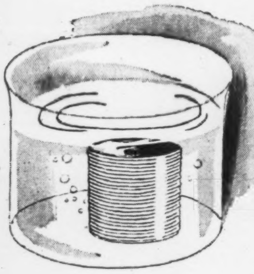
News about

B.F.Goodrich Chemical *raw materials*

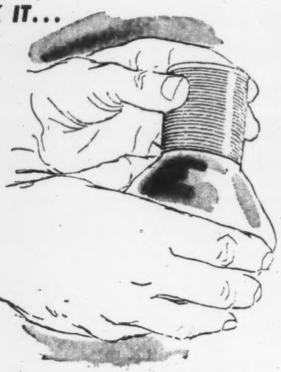
MOLD IT...

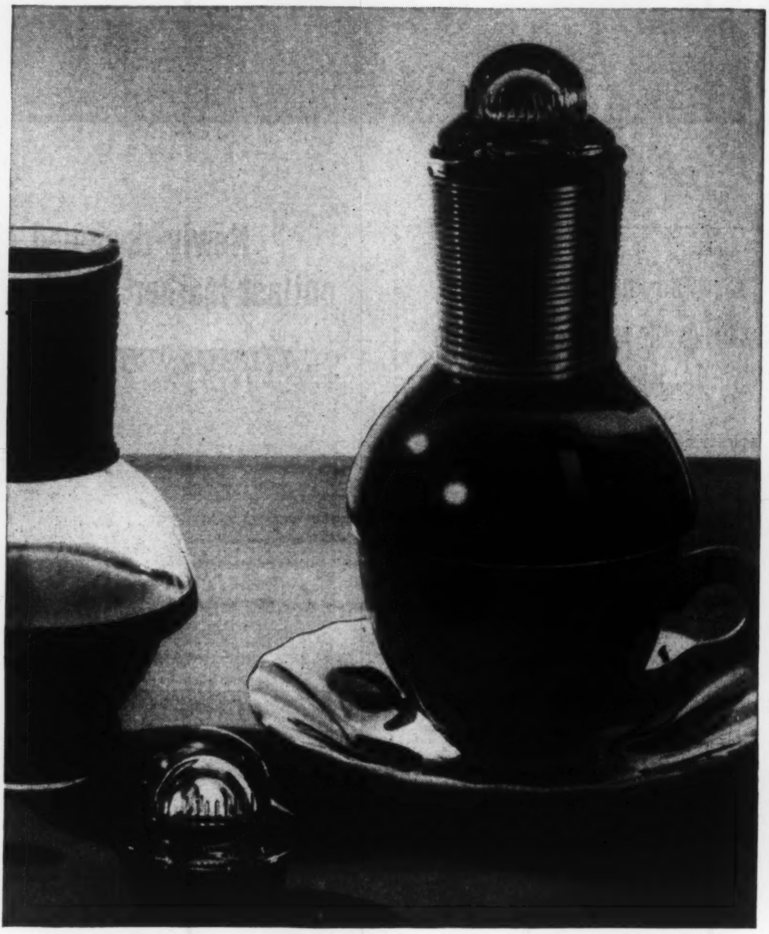


DUNK IT...



SHRINK IT...





Unique property of GEON plastics suggests new design applications

THE Geon vinyl plastic collar on this coffee server provides heat insulation and it's highly decorative in its six attractive colors. It is resistant to grease, detergents, acids and abrasion, and it comes through sterilization in autoclaves and dishwashers without damage.

1. **Collars mold accurately and retain their form, when made of Geon.**
2. **Dilated in an acetone solution, they can then be dropped over the neck of the bottle.**
3. **The acetone evaporates, causing the collar to shrink tightly in place.**

This new way to assemble Geon polyvinyl products has already suggested similar uses to other designers. One manufacturer slips protective sleeves on piping until refrigeration units are assembled. Another installs handles on his appliances by this dilate-and-shrink method.

For information on Geon, write Department DO-3, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

A TRADE MARK OF B. F. GOODRICH CHEMICAL COMPANY
Geon
Polyvinyl Materials
A DIVISION OF THE B. F. GOODRICH COMPANY

Visit us at the Plastics Show! Booths 422-426.

B.F.Goodrich

GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

—ITEM 598—
For More Information Circle Item Number on Yellow Card—page 19

COPPER gives you more to talk about

Are you in a business whose product needs constant selling? Most products do.

Perhaps yours must be sold to many people . . . your own sales organization . . . distributors, retailers, consumers.

Copper gives you more to say for your product.

And especially where you're selling against competition, *copper can make the difference.*

For no substitute possesses the combination of characteristics you get . . . and offer . . . in copper and its many versatile alloys.

Today, as always, the phrase "made with copper" signifies *quality.*

That's because people's experience with copper is favorable. There is no doubt about copper's performance.

If mere acceptance isn't enough for your product . . . if competition makes *preference* important . . . give yourself the advantage of copper or one of its many alloys.

You will find that COPPER gives you more to talk about—*helps you sell!*

COPPER & BRASS
RESEARCH ASSOCIATION
420 Lexington Avenue, New York 17, N. Y.

. . . AN INDUSTRY SOURCE OF TECHNOLOGICAL AID, INCLUDING A LIBRARY OF TECHNICAL LITERATURE AND A COUNCIL OF SPECIALISTS

COPPER OR ITS ALLOYS PROVIDE THESE ADVANTAGES:

Best conductor of electricity commercially available

Does not rust . . . high corrosion resistance

Best heat transfer agent of all commercial metals

Easy to machine, form, draw, stamp, polish, plate, etc.

Welds readily . . . excellent for soldering and brazing

—ITEM 599—

For More Information Circle Item Number on Yellow Card—page 19

Next Page—ITEM 600→

Craftsmanship of the 20th Century

MONSANTO

Designers constantly face the challenge of making next year's products more serviceable, more salable. More and more of them are working out their problems with the assistance of plastics engineers. This picture-story tells how craftsmen of the custom molding industry helped utilize the unique properties of plastics in the fabrication of an important refrigerator component. Perhaps custom molders can contribute to solving your design problems in the same way.

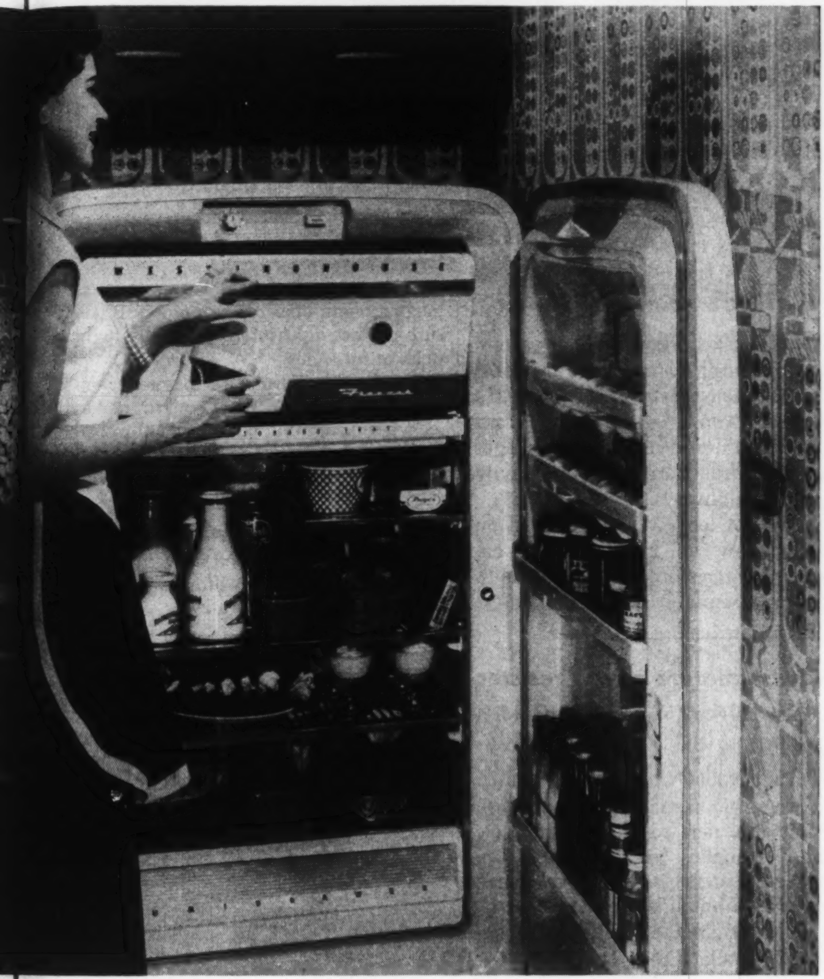
How custom molding and Lustrex Styrene solved a complex Westinghouse design problem...

DESIGN OBJECTIVES called for providing additional storage facilities in a new line of refrigerators. Westinghouse designers drew up plans for incorporating egg racks, butter and cheese compartments, shelf pockets, etc., in the door. The liner Westinghouse visualized had to function as a structural member of the door. It also had to conform to the new trend toward color and be produced within strict cost limits. The design raised engineering questions which focused on material specifications and production methods.

MATERIAL SPECIFICATIONS for the door liner stressed outstanding "formability" to minimize assembly problems. The material had to be hygienically smooth and stain resistant, have high gloss and meet specific color requirements. It had to have great impact strength, moisture and warp resistance, and a low thermal coefficient of expansion and contraction. In addition it had to have sufficient tensile strength to withstand the cross-sectional stress imparted by one side hanging on two hinges. The search for a material with these combined properties narrowed down to a modified styrene plastic (a material which had already proved its qualifications in Westinghouse trays and beaker strips).

PRODUCTION of the door panel required a mold designed to impart a cross-section wall thickness that had to vary precisely in increments of thousandths of an inch over an area of 2,250 square inches. This permitted molding the basic piece from a single sprue, yet provided an efficient flow pattern with minimum amount of styrene displaced in the cavity. Dies were designed and built by Major Mold and Die Co., Detroit, for injection presses of the 400-oz. capacity range.

PERFECTED DOOR LINERS are molded of Monsanto Lustrex high impact styrene. Despite new advantages of glamorous appearance and rugged durability, material cost averages lower than for materials previously used. The soft color tones (blue, green, beige and white) are permanently infused into the molded piece, eliminating costly refinishing and assembly steps, while adding functional sales appeal to this popular Westinghouse product.



This is one of hundreds of design and production problems which have been solved by utilizing the facilities of the plastics custom molding industry. These 20th Century craftsmen are available to manufacturers designing for greater efficiency and lower costs. As a major supplier of styrene and other plastics, Monsanto is in a position to introduce you to custom molders who will put their knowledge and skills to work for you. If you are considering a design change for your product line, be sure to investigate plastics. Write to Monsanto Chemical Company, Industrial Applications Dept., Springfield 2, Mass.

Custom molding companies assisting in the development and molding of this large door liner include Amos Molded Plastics Co., Bridgeport Molded Products, General American Transportation Co., General Machine & Tool Works, Prolon Div. of Pro-phy-lac-tic Brush Co., Worcester Molded Plastics Co. In addition, some of the liners are molded by Westinghouse at their Columbus, Ohio, plant.

Investigate Monsanto's completely balanced line of styrene formulations developed for particular applications and sold under the trade name...

LUSTREX
Styrene Plastic

MONSANTO

★ Control Components Digest ★

News and notes on resistors, rheostats, relays, motor controls, dimmers and other control components

SYLVANIA'S SOFT BLUE MERCURY VAPOR LAMPS are seen on many modern thoroughfares. Integral Ward Leonard resistor in each lamp contributes to reliable operation.

Improved mercury-lamp design features sealed-in resistor

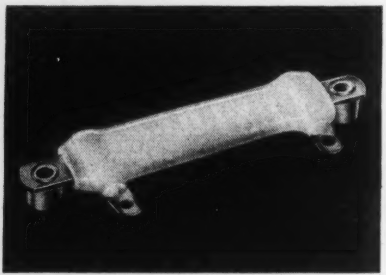
Seal it in and forget it, for the lamp's life of 6000 hours plus!

That's the way engineers at Sylvania Electric Products Inc., Salem, Mass., treat the current-limiting resistors in their modern, improved mercury-vapor lamps.

And, naturally, for the heavy-duty, heat-, moisture- and ultra-violet-proof starting resistors, to be sealed up in these lamps, Sylvania engineers chose Ward Leonard Vitrohms.

These rugged resistors not only take the temperatures (to 750°F), but are immune to the heavy vibration encountered on or near bridges, ramps, railroad crossings or heavily-traveled highways.

Why not let a Ward Leonard engineer show you how Vitrohms can solve your resistor problem. Write today for complete information.



NEW MINISTRIP RESISTOR

New miniature power resistor

A new 20-watt Ward Leonard "Ministrip" resistor is now available.

Recommended where space is limited, but where no sacrifice can be made in quality, the new resistor features low, built-in mounting brackets (2-5/16 in. between centers) and an oval-shaped core for maximum strength.

Stock resistance values to 50,000 ohms; 5% tolerance.

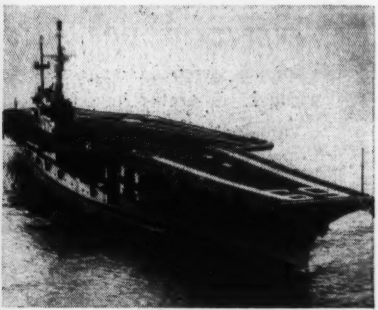
Failure-free parts key to system reliability

Roughly speaking (and skipping a lot of mathematical subtleties) if you double the number of parts in a complex system—other things being the same—you'll cut in half its life expectancy.

The modern trend is toward more and more complex jobs for electrical and electronic gear. Doubling—and more—the number of parts goes on all the time. And yet it's vitally important that overall system reliability not be impaired.

That's why at Ward Leonard you'll find such painstaking attention devoted to increasing the reliability of our products. From incoming raw material to finished part, our careful attention to every phase of production and every inspection and test assures you of a product you can count on in *your* system.

CHECKING CONTACT PRESSURE on a Ward Leonard relay—one of the many 100% inspections and tests that assure its final quality.



USS FORRESTAL. Photo courtesy Newport News Shipbuilding and Dry Dock Company.

MAG-A-TROL for USS FORRESTAL

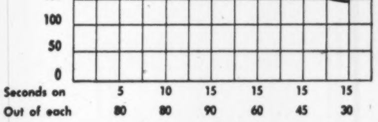
Precision-controlled lights guide pilots to the flight deck of the USS Forrestal, largest aircraft carrier.

The new carrier uses Ward Leonard magnetic-amplifier-type dimmers to insure correct light intensity on the flight deck at all times.

Besides the Forrestal's magnetic amplifier dimmers, Ward Leonard makes *all* types of lighting controls (autotransformer, reactance and resistance) for fluorescent or incandescent lamps.

Design aid for intermittent duty

A power resistor used only intermittently may be used at wattages in excess of its continuous-duty rating.



The curve above will help designers figure allowable dissipation increases for Ward Leonard Vitrohm and Ribflex resistors for various duty cycles. Assumed maximum temperature rise: 375°C; resistor spacing: 2½ in. This is one of many useful curves contained in our 64-page Catalog #15—ask for it today. 6.7

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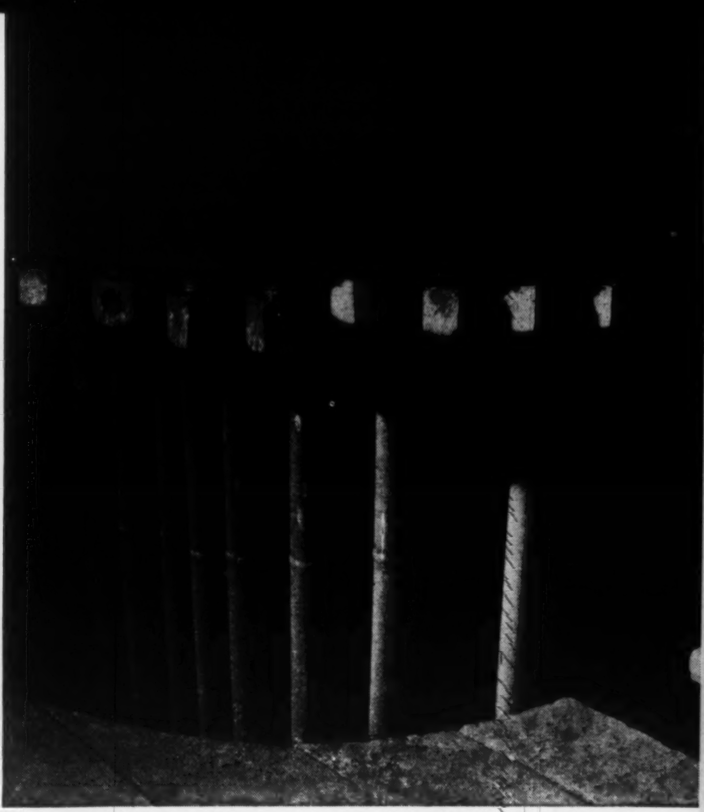
ELECTRIC COMPANY
58 SOUTH ST., MOUNT VERNON, N. Y.

Result-Engineered Controls Since 1892

RESISTORS · RHEOSTATS · RELAYS · CONTROLS · DIMMERS

—ITEM 601—

FOR SCUFF-RESISTANT BEAUTY. This Sunroc water cooler has, as standard equipment, a Stainless Steel kick plate for protection against scuffing and corrosion when floors are mopped. The deep drawn top is also made from Stainless. It's bright and inviting, and easy to clean.



FOR LONG, HARD SERVICE. Some of the Stainless Steel tubes in this bundle are 20 years old, despite the fact that they have been in continual service in a thermal cracking unit at a major southwestern oil refinery. Even though some of them have been lengthened by heliarc welding, they still retain their ability to handle corrosive products.

NOTHING *can equal* *Stainless Steel*

FOR SANITATION. This is a Stainless Steel rotary washer at a baby food plant of Gerber Products Company. Stainless Steel was used because of its great corrosion resistance, because it will not contaminate the food products, because it is so very easy to clean. Gerber's uses a lot of Stainless Steel processing equipment—including peelers, bins, steamers, holding tanks and filling machines.

• No other design material can match Stainless Steel in its *combination* of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers the widest range of types, finishes and sizes available in the United States.

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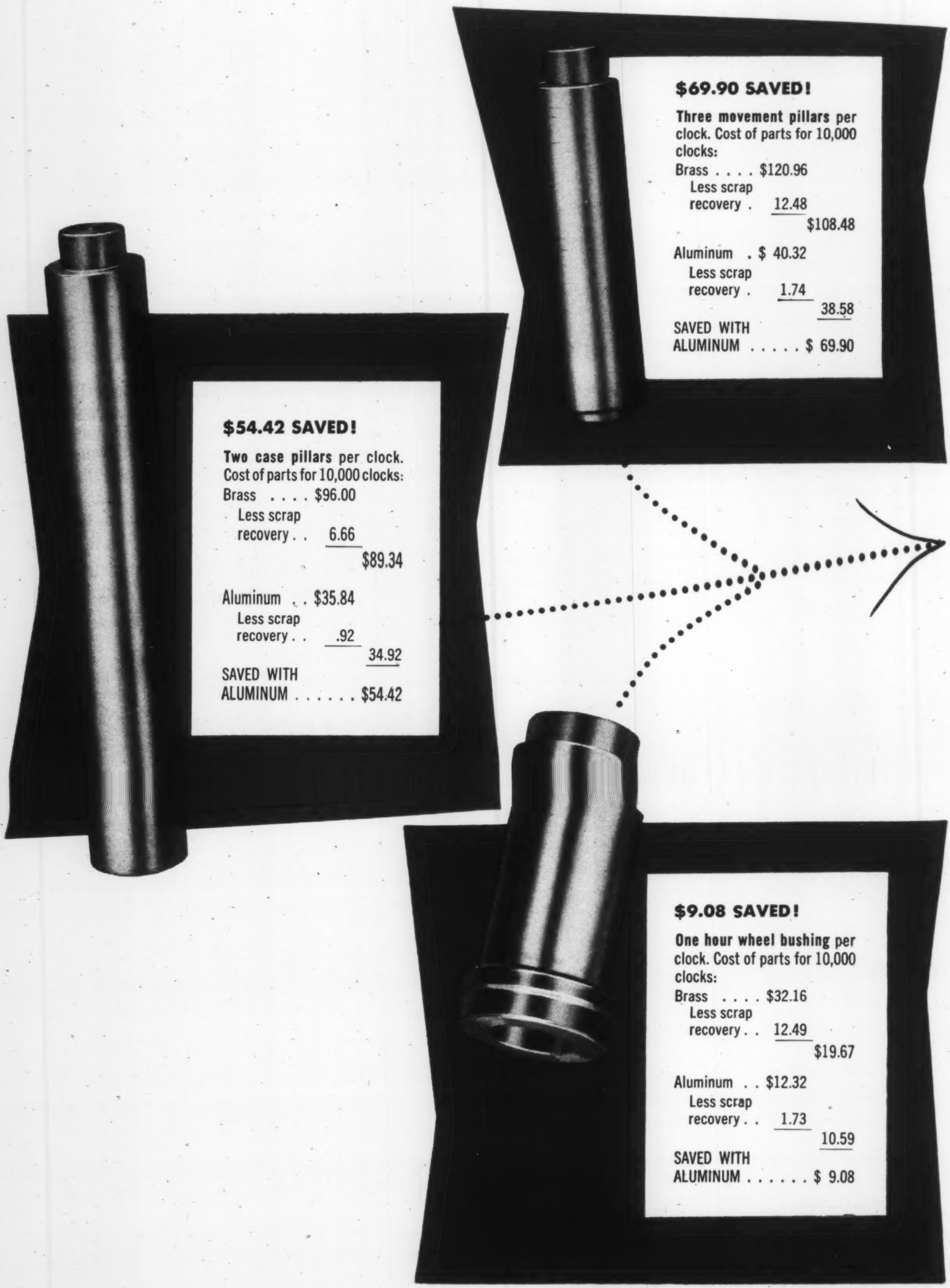
USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

UNITED STATES STEEL

Aluminum cuts costs on three screw



$69.90 SAVED!

Three movement pillars per clock. Cost of parts for 10,000 clocks:

Brass	$120.96	
Less scrap recovery .	12.48	
		$108.48
Aluminum .	$ 40.32	
Less scrap recovery .	1.74	
		38.58
SAVED WITH ALUMINUM		$ 69.90

$54.42 SAVED!

Two case pillars per clock. Cost of parts for 10,000 clocks:

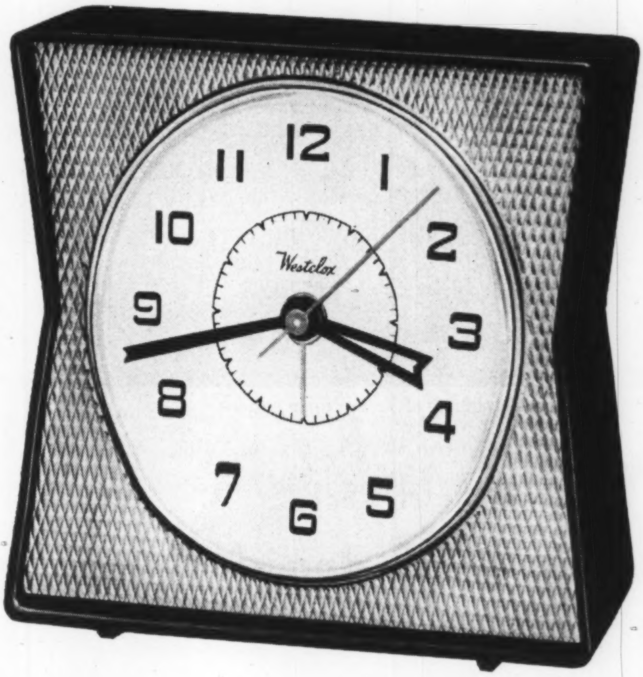
Brass	$96.00	
Less scrap recovery . .	6.66	
		$89.34
Aluminum . .	$35.84	
Less scrap recovery . .	.92	
		34.92
SAVED WITH ALUMINUM		$54.42

$9.08 SAVED!

One hour wheel bushing per clock. Cost of parts for 10,000 clocks:

Brass	$32.16	
Less scrap recovery . .	12.49	
		$19.67
Aluminum . .	$12.32	
Less scrap recovery . .	1.73	
		10.59
SAVED WITH ALUMINUM		$ 9.08

machine parts for WESTCLOX



WESTCLOX MANAGEMENT SAYS:

"We recommend that aluminum be used in all cases where it can save us money, as it does with the three parts shown here. Lower raw material costs without any sacrifice in machining time is the main reason for the savings we get with aluminum."

WESTCLOX ENGINEERING SAYS:

"In addition to its economy, we find that aluminum is often more suitable for certain parts than brass or steel."

WESTCLOX PRODUCTION SAYS:

"We find that aluminum screw machine stock machines easily and has equal or better machining rates than other metals. No special tooling or other preparation is required."

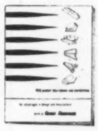
THE EXPERIENCE of Westclox, Division of General Time Corporation, is more evidence of this important fact: when you specify *aluminum* screw machine parts you often get *better* parts for *less money*.

A pound of Kaiser Aluminum screw machine stock gives you *three times* as many parts as a pound of brass or steel. And these parts provide you with a unique combination of advantages, including lightness with strength, handsome finish, corrosion resistance, good heat and electrical conductivity.

For more information or assistance, look for our local number in the classified telephone directory under the heading "Aluminum" or contact one of our many distributors. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service



WRITE FOR VALUABLE LITERATURE!

Product catalog contains Kaiser Aluminum availabilities, specifications, alloys. See in Sweet's File for Product Designers or write for your copy to: Industrial Service Division, 6122 Kaiser Building, Oakland 12, California.

—ITEM 603—
For More Information Circle Item Number on Yellow Card—page 19

MULTIMET alloy wraps are joined by welding in the fabrication of aircraft cabin heaters.

MULTIMET Alloy Wraps
Absorb the Heat from a 3500 deg. F Flame

MULTIMET alloy wraps are used to absorb the intense heat from burning aviation gasoline in aircraft cabin heaters. The spirally wrapped alloy sheet transfers the combustion heat to fresh ventilating air. Very thin sheet—only 0.025 in. thick—does an excellent job here despite the high metal temperatures and the oxidizing conditions.

Rigorous 1,000-hr. tests were conducted before MULTIMET alloy was selected for this job. It has now been the standard material for seven years. The excellent high-temperature properties of the alloy made it possible for designers to use thin sections, which insure a light, compact heater, with excellent heat-transfer efficiency.

MULTIMET alloy is one of many HAYNES high-temperature alloys for economical use over a wide range of operating conditions. It has given good service for engine manifolds, turbine blading, heat-treating equipment and many aircraft components. For a copy of a booklet describing HAYNES high-temperature alloys, and for prices and sizes of MULTIMET alloy, get in touch with the nearest Haynes Stellite Company office.

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—ITEM 604—
For More Information Circle Item Number on Yellow Card—page 19

PRESENTING...

the NEW LINK-BELT MOTOGEAR

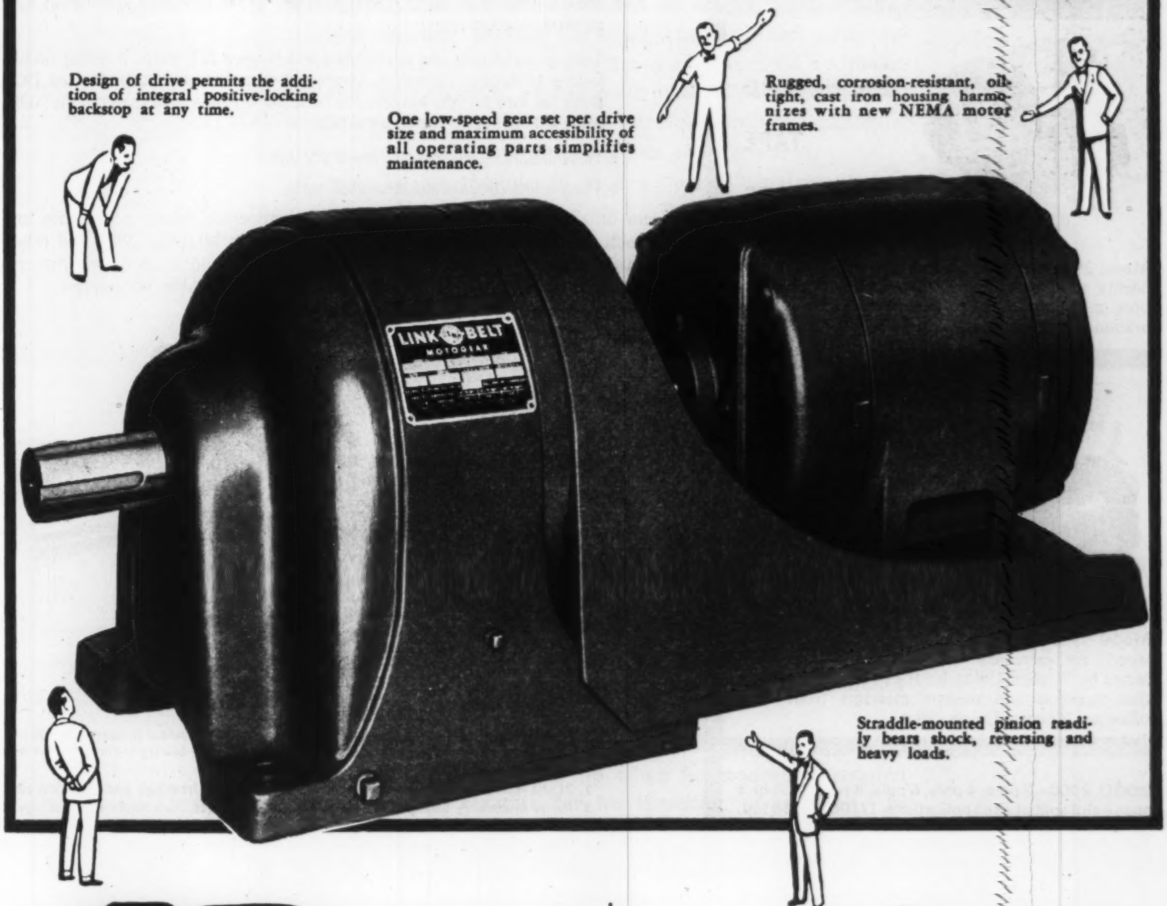
for bracket-mounting all foot-type

NEMA motors—all makes and enclosures

If drives in your plant operate continuously, the dependability of Link-Belt Motogears provides a sure means of minimizing costly, production-crippling downtime. Replacing a motor is simple and easy: just remove four bolts and separate the coupling—no need to drain oil. And design of the bracket assures rapid motor realignment. Sizes up to 60 hp; ratios from 6.2:1 to 292:1.

Link-Belt
Motogears

These are just a few of many advances in design you'll find detailed in 28-page Book 2447. Get a copy now from your nearest Link-Belt office or authorized distributor of Link-Belt products.



Design of drive permits the addition of integral positive-locking backstop at any time.

One low-speed gear set per drive size and maximum accessibility of all operating parts simplifies maintenance.

Rugged, corrosion-resistant, oil-tight, cast iron housing harmonizes with new NEMA motor frames.

Straddle-mounted pinion readily bears shock, reversing and heavy loads.

The new, improved Link-Belt line also includes compact Gearmotors with flange-mounted NEMA motors combining flexibility with outstanding design innovations.

LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,890

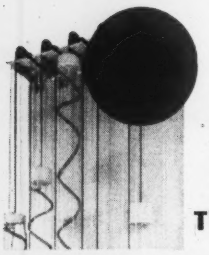
—ITEM 605—

For More Information Circle Item Number on Yellow Card—page 19

NEWLY DESIGNED

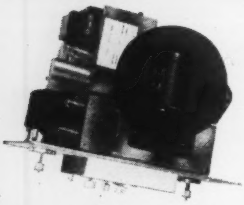
Howard Induction Motor Model 2900

Offers 18% Overall Improved Performance and Efficiency for Critical Applications



MERIAM MULTIPLE TUBE COMMON WELL TYPE MANOMETER

Model 2900 motors with gear units are used to motorize each well, quickly position the datum level required for the pressure range of the test involved.



MAGNECORD TAPE RECORDERS

Model 2900 is used in several MAGNECORD high fidelity professional units. Extremely quiet operation, minimum cogging, minimum mechanical vibration are major points in selection.

WESTERN UNION RECORDER #5616B

Mfd. by J. P. Seeburg Corp.

Model 2900 motors maintain an exactly constant speed, are extremely quiet and dependable. Selected by Western Union for their Recorder #5616B that transmits and receives messages from users office to Western Union office.

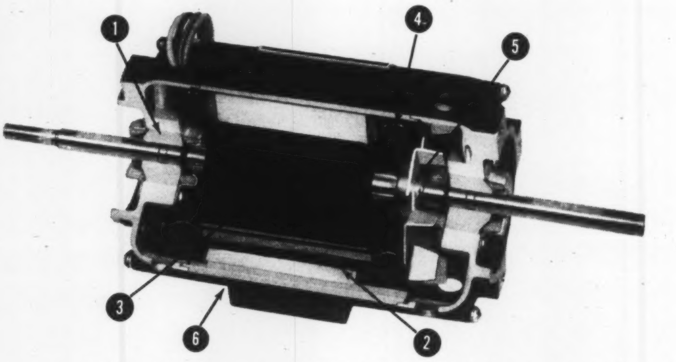
MODEL 2900—2 pole, 4 pole, 6 pole, 8 pole, 1, 2, or 3 phase and split phase applications. 1/100 to 1/15 h.p.

The applications shown above are just three of many applications now served by HOWARD MODEL 2900 motors.

The new HOWARD 2900 motor incorporates an improved lamination and is a 24-slot lamination versus a 16-slot lamination in the old 2900 motor. The advantages are as follows:

- With the same watts input, there is more power output. For a given weight and space more power is available.
- With less watts input to develop the same power output, the motor runs cooler.
- Because of the cooler running motor, there are all the attendant advantages of lower heat rise.
  Some of these are: a. Longer Motor Life b. Longer Bearing Life c. Minimum lubrication trouble d. Ability to operate in higher ambients.
- There is reduced "cogging" effect, especially on the reluctance synchronous and standard Induction types.
- There is considerably less external field with the new 2900 Motor. A leading manufacturer of dictation equipment, reports that after thorough tests on the new 2900 Motor the external field was found to be so low that it is unnecessary to use baffle material to screen out the magnetic field.
- There is substantially less mechanical vibration.
- There is less electrical and mechanical noise.

Prices on the new Howard 2900 motor are moderate. Many gear ratios are available. Write today for complete information on MODEL 2900 and other Howard Induction motors, Series and D. C. motors and Shaded Pole motors. Howard's fractional h.p. motor selector chart is available on request.



1. "Selected" ball bearings permanently lubricated, sealed and shielded or sleeve bearings with large felt oil reservoirs with oil return system (shown). Sleeve bearing motors provided with ball thrust bearing for vertical operation.
2. 24 slot lamination design for quiet, cool operation. Stamped from high grade electrical steel.
3. Rotors dynamically balanced, skewed to give uniform torque characteristics with change of rotor angle.
4. Windings of heavy Formex insulated wire, impregnated and baked with top grade electrical varnish.
5. Internal fan for cooling. 6. The case is a sturdy rigid casting.

Other Howard motors: UNIVERSAL & D.C. 1/200 to ½ h.p. • SHADED POLE 1/2000 to ⅛ h.p. • INDUCTION 1/1400 to ⅛ h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

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—ITEM 606—

For More Information Circle Item Number on Yellow Card—page 19

MACHINE DESIGN
May 3, 1956

On the Shoulders of Giants

NOVELISTS, Hollywood and TV have given history an appeal that too few of us felt in school. Wars, kings and empires seemed hopelessly tangled and quite remote in time and space. But whether it's Richard III by Shakespeare and Sir Laurence, or Racket Squad Robin Hood holding off a score of swordsmen, we sense and see both the changing and the enduring characteristics of man and his world.

It may be worthwhile to look at early "engineers" and their achievements in the same way. Or, as Dick Hartenberg and Jacques Denavit remark in the article beginning on the next page,

> Existing forms—whether of government and social life, or mechanisms and machines constructed from them—are determined and explained not by simple examination of what is before us, but rather what is behind us.

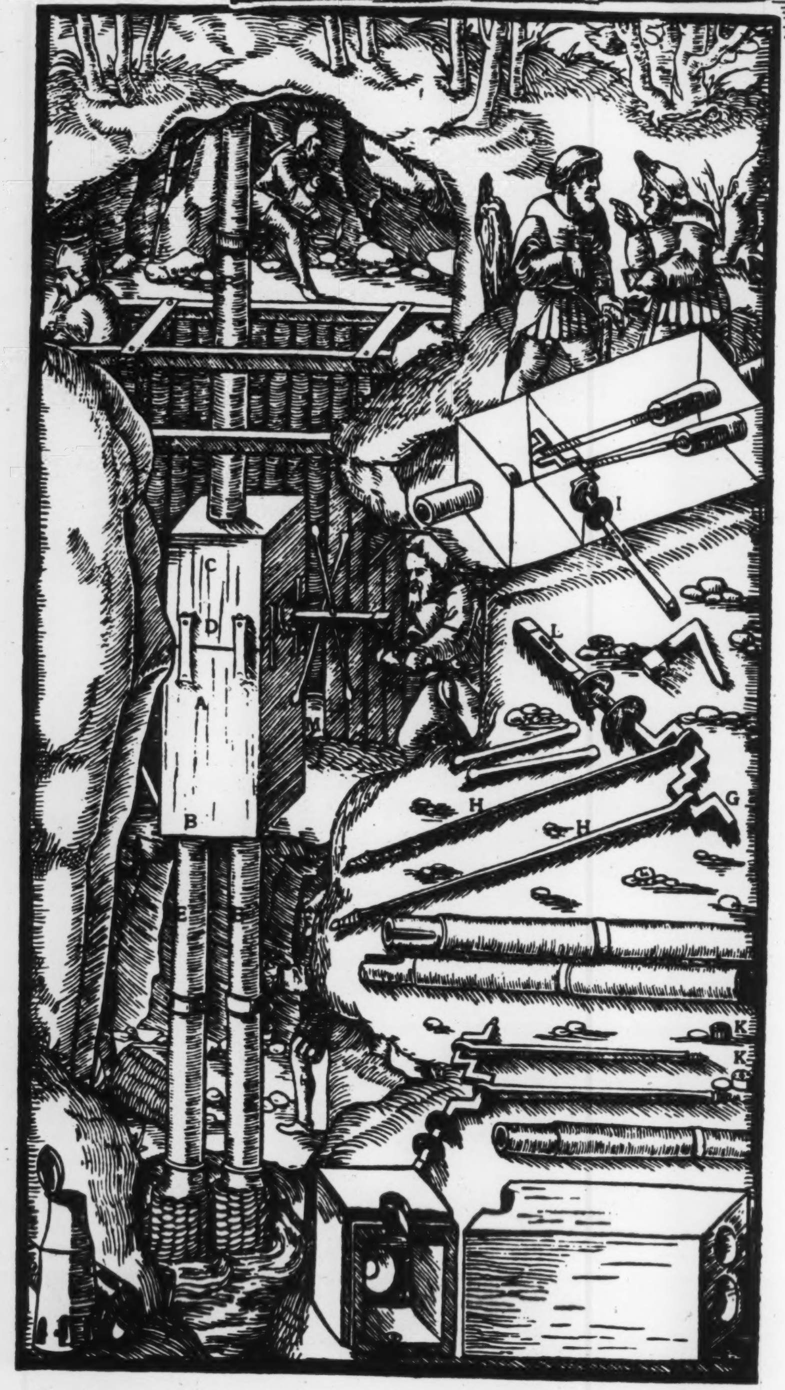
The long look at the origin and development of things with which engineers are still occupied today gives perspective—a sense of order and orientation. The same holds true for an awareness of things out of the more recent past. Only the foolish ignore the prior state of the art, and tackle today's assignments with nothing but bare hands and brute force. Engineering records, patents, articles, papers, books—all are history. They both lead and caution, besides saving time, money and frustration.

And with these gains comes a respect for the contributions of many. Newton summed it up when he modestly accepted his contemporaries' plaudits for his invention of calculus. In essence, he said, "It wasn't too tough, fellows, I but stood on the shoulders of giants."

Ben Hummel

ASSOCIATE MANAGING EDITOR

Men and Machines



A—Box. B—Lower part of box. C—Upper part of box. D—Clamps. E—Pipes below the box. F—Column pipe fixed above the box. G—Iron axle. H—Piston rods. I—Washers to protect the bearings. K—Leathers. L—Eyes in the axle. M—Rods whose ends are weighted with lumps of lead. N—Crank.

MAN'S daily life for the ages past found him doing certain routine tasks that he strove to make easier, or it found him trying to do jobs beyond his powers. The things of greatest importance were the handling of heavy weights, the raising of water, fighting fire, mining, pressing wine and oil, and the development of missile weapons. As an individual, man at first did everything by main strength and awkwardness, and was at the most quite ineffective when it came to doing things in a big way. During the course of time he began to search

Agricola's *De Re Metallica* (1556) contains 292 superb machine drawings. Where necessary they are made self-explanatory by the technique of "laying out the pieces." In this drawing of a pump (two suction cylinders, one pressure cylinder), the "glass-box perspective" has been used for perhaps the first time. Note the flywheel equivalent given by the two iron bars *M* thrust through the crankshaft. (From Hoover translation)

. . an informal history

By R. S. Hartenberg and J. Denavit*
Dept. of Mechanical Engineering
Northwestern University
Evanston, Ill.

History can be stuffy—or fascinating. The difference is often whether an account of the past gives some insight into things of current concern. This article is the first of several designed to give an engineer's view of the origins and developments of machines and mechanisms.

for the easier ways of doing jobs, or he took on more ambitious projects. He invented devices to aid him—devices to multiply his force, do a better job, do it more quickly or more effectively, do it with greater safety—as being able to hit an enemy from a distance.

It is from the story of man's development—his searches and his accomplishments—that we are able to trace, not always in continuous fashion, the ways and means of the improvements that he devised. The development through the ages is a subject with many ramifications, and this survey is of necessity brief. It is only possible to indicate the general pattern of when and how the basic components of mechanisms and machines were first put into use. This involves dates, of course. A date with but one fact attached to it means mighty little. It isn't until other facts—nontechnical ones—are grouped about it, that a date has perspective, implication and color. Dates aren't history, but they are needed to establish the order of things. The technical happenings must be seen within the framework of what was happening in the world, or at least that corner of the world which gave rise to the technological development. Things are invented from necessity, not from the sheer exuberance of just inventing.

Consider the matter of handling heavy weights, a fundamental problem. Five "simple machines" for "moving a given weight by a given force" were described by Hero of Alexandria in the first century A.D. They were the wheel and axle, lever, pulley, wedge and endless screw. We shall not argue about or defend the term "machine" as Hero used it. But we must note that until well into the 19th century these "machines" were held to be the primary or constituent parts of all assemblages that came to be called machines. However, much of this machinery was not at all concerned with handling weights but was devoted to the manifold duties born of the Industrial Revolution of the late 18th century.

The latter part of the 19th century saw tremendous technological advances made because of various pressures. Some of them were territorial expansion, world trade, a general demand for a greater variety of goods in large quantity and at low price, an enormous scientific curiosity, and a greater awareness of physical facts. Ideas about machinery underwent a change when Reuleaux in 1875 defined the basic mechanical components of all machines as six—the screw, wheel (including gears), crank (as linkwork), tension-compression links (belts and chains, hydraulic lines), cam and ratchet. Although this classification scheme is not accepted by all, much subsequent work has followed it, as is witnessed by the chapter headings of many machine design texts. Certain developments in fluid mechanics and electricity since Reauleaux's time have persuaded some of his followers to extend the list by including them. However, we shall consider only the first six as machine components, for they are strictly mechanical in nature, and are easily identified when we look for the time of their first appearance.

It comes as somewhat of a surprise to discover that all of these parts are very old—that they were, in fact, invented and used at wholly unknown times and under wholly unknown circumstances. The dim story of their origins and the account of their growth led to this informal history which tries to relate things and events with time.

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*Now, French Air Force.

LEGENDS, rock carvings, paintings, manuscript fragments and actual remnants of ancient times disclose the presence of a part such as a roller, pulley or screw. The architects (as engineers were called in ancient times) wrote very little indeed, and historians were not much concerned with the mechanical details associated with the events of which they wrote. Under the circumstances, it is impossible to wrangle about priority and invention. There were some individuals—as Aristotle and Archimedes—who gave intelligent discussions of certain devices, but it is wrong to blandly assume that they invented them. The evidence shows that they appreciated them, and were thus able to interpret and exploit them. It is not until the last few centuries—say from 1600 onward—that it is possible to identify a name and an invention or innovation.

But even the written word may be deceiving, for poetic form and translators have to be considered. To find and interpret the artifacts of people who wrote little hundreds of centuries ago calls for the combined efforts of a philologist, an archeologist and a field specialist, for much is buried in a welter of obsolete technical terms. The elusive character of words is always felt on attempting a translation. It has been disconcerting to note that sometimes two translators or reporters did not agree, even on major items. When the translation is from an ancient language, the meaning of any word is largely inferential.

Who can say precisely what a certain word of a long-dead tongue meant when today we recognize that there are differences as well as shifting of word values in languages that are "the same"? If, as Americans, we say that we speak English, we do (or should) realize that in word usage there is often a vast difference in meaning. What an American calls corn (if he is speaking of the plant!) is maize to the English, who think of corn as any edible small grain. An article of furniture of which a writing desk is a part is called a bureau in England but a secretary in the United States, where a bureau is a chest of drawers for linens. Languages are capricious. The new Revised Standard Version[1] of the Bible that has caused such a furor is an example of how word meanings are always subject to interpretation in terms of events and collateral knowledge, and are revised when further study, in this case several centuries' worth, is brought to bear. It will be recalled that many of the Bible manuscripts are younger than those concerned with things technical.

HISTORY, the study of past human affairs, sheds light on the present. A knowledge of the past gives us an understanding of the present. Existing forms, whether of government and social life, or machine parts and the mechanisms and machines constructed from them, are determined and explained not by simple examination of what is before us, but rather by what is behind us. Part of the fascination of kinematics lies in its association with the human wants that brought forth the mechanical marvels of the present.

Then, too, we gain through history some appreciation of the intellect and ability of past generations. We must reflect, and realize, that the earlier engineers and builders did not have the accumulated knowledge and the ease of obtaining information that we have today, and that these people most certainly had the same amount of curiosity and power of observation as the present generation. We notice an intelligent adaptation of material and knowledge that met the requirements of time and usage—the satisfying of a want. This is still going on, but today we have more materials and ideas from which to choose to make up our solutions to the problems confronting us.

There is often some doubt about which devices were actually built and which existed only "on paper." The extensive use of wood, animal fibers and hair did not make for articles that would be

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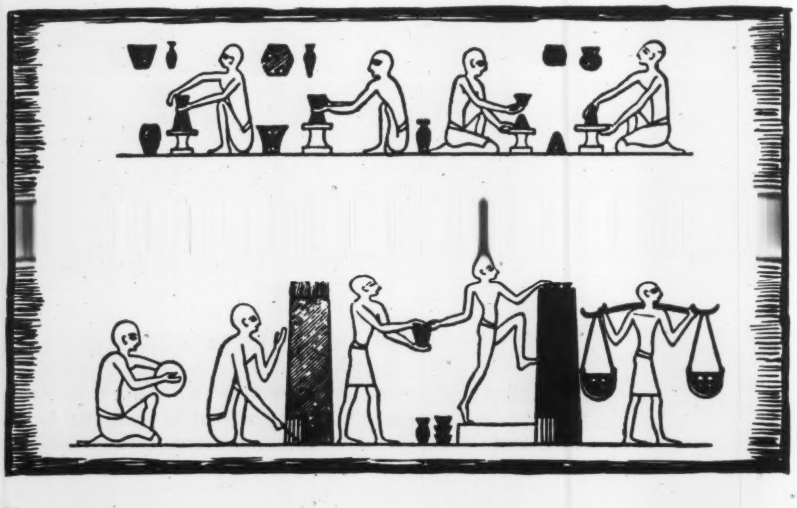
[1] The preface gives a very clear picture of the difficulties encountered in interpreting the events of the old days in terms of a modern language.



The potter's wheel,

Egypt: shaping, firing and marketing. (From Usher) preserved for centuries. Archeological finds of metal pieces matching descriptions or details in carvings and paintings of authenticated age give proof of the existence of certain of the devices. Theory and speculation, even centuries ago, were stronger than practice. The notebooks of Leonardo da Vinci (late 15th century) show sketches of a great many devices; yet it is known that only a few were built in his day.

The information about the technological developments of the ancients is limited. One reason is that even though the old Greek and Roman cultures developed democratic social structures they were essentially aristocratic in nature, scorning the hand-worker but extolling the philosopher. In those days, theory was good and practice deplorable. To talk, think, write poetry and rule—those were the dignified things of life. There were plenty of slaves for the menial tasks. The historian, in mentioning wars and beleaguered cities, spoke of offensive and defensive weapons, of fortifications, of bridges and tunnels, and how these things contributed to the course of events. But it was only by oversight (or so it seems!) that the name of the artisan or engineer was mentioned in all briefness, for he stood hidden by the shadows of events and rulers. Extremely little technical matter was recorded.

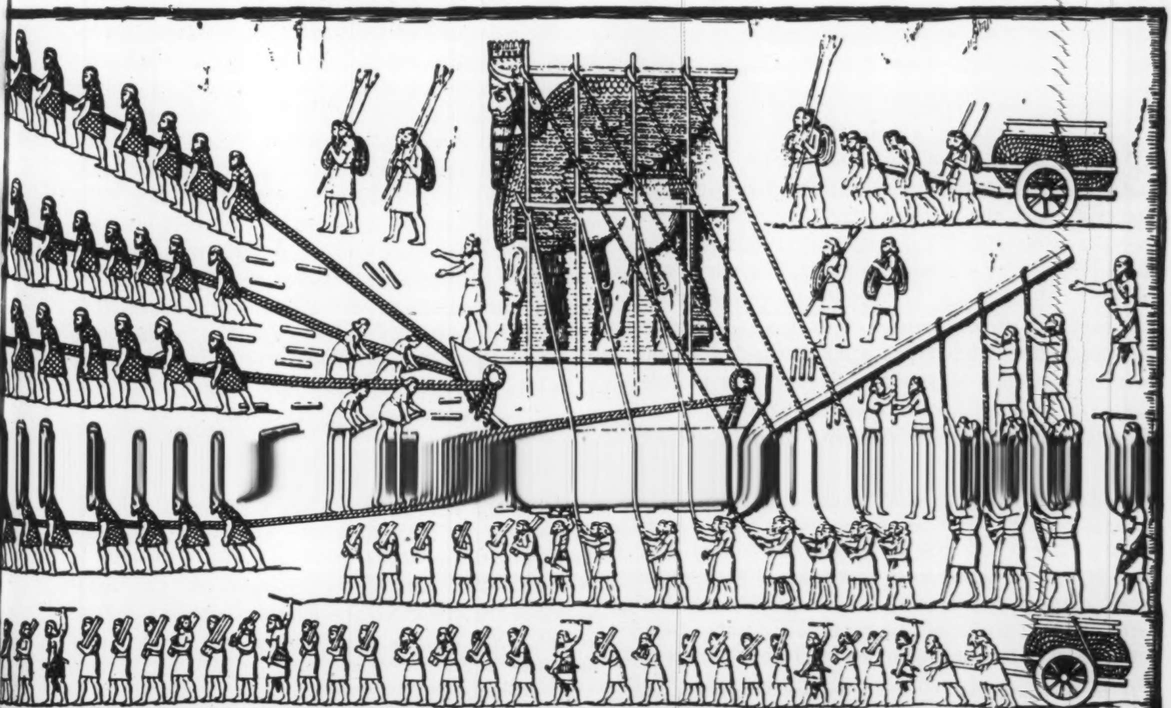
A second reason ties in with the fall of the various empires, for in the wars of conquest the few libraries of ancient times were destroyed by accident or purpose, leaving the story of the past to be told by fragments that somehow escaped. The empire conquerors had little or no inerest in the glories that they had destroyed; they were busy maintaining their positions in the occupied countries.

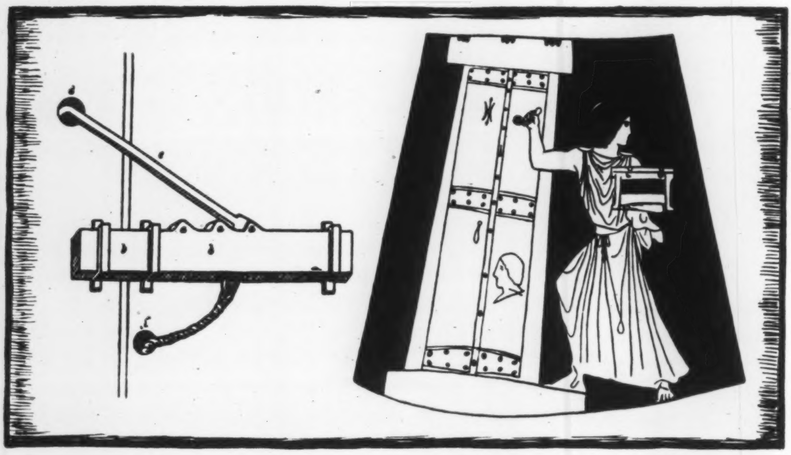
THE oldest nation of which we know, the Sumerian, flourished in western Asia in the lowlands between the Tigris and Euphrates Rivers. This region cradled the human race; it is the land of origins, and the vast ruins are quiet evidence of the successive civilizations. The cuneiform system of writing, the earliest of record, was used by the Sumerians about B.C. 7000. The wheel concept—a disk on an axle—has been dated around B.C. 3500; the Sumerians used the wheel for vehicles as well as the making of pottery.

The early wheel was solid and very heavy. The spoked wheel, requiring much more craftsmanship, was not introduced until about B.C. 2000; its application was limited to war chariots, with speed and maneuverability as the design considerations.

The ancient Egyptians, the pyramid builders (B.C. 2900-2750), knew only the most elementary mechanical appliances—the lever, the roller, the use of vast embankments, and the wedge. The Egyptians do not appear to have used the roller as a pulley. Although many pictures and models of sailing boats are known, halliards (lifting lines for sails) are shown rove through rings or over rounded metal when it was necessary to change the direction of the pull. The ancient Egyptians and Assyrians did make use of the sled or roller on sleepers. Even though the roller was employed, the wheel (a roller turning on an axle) played no important part. Ramses II (B.C. 1292-1225) used chariots in his

Transport of skid-mounted monument in Assyria. Rollers underneath and lever at the rear of the skids aid the men on the tow-lines, who lean into their traces at the command of the man on the "stone-boat." (From Merckel)





Lock of the Homeric period. The left view shows the inside of the door, with keyhole at *d*. The latch *b* carries three bosses, *a*, against which the key, *e*, was applied to shove the latch to the right; the key was about 2 ft long. In the right view, the girl has the key in the keyhole. (From Diels)

wars[1] against the Hittites, but apparently did not use wagons for the transport of gear as did the Hittites. Some examples of Egyptian chariots of the 14th and 15th centuries B.C. have survived in complete form. The wheels are deftly fitted together from many pieces, and have a delicacy of line matching that of the light chariots. The Assyrians used solid wheels to move heavy objects while the Egyptians were still utilizing sleds and rollers.

Doors with pivots seem to appear in Egypt about the time of the Fifth Dynasty, B.C. 2750-2625. They were made of several planks running in the vertical, with an upper and lower spindle an integral part of the last plank. Later, bronze pivots were used. From this Dynasty there are pictures showing drilling operations—not only the bowdrill, but also a more sophisticated form involving a crank of sorts and a flywheel. Copper and gold hinges with pins (the "modern" type) were found on the caskets and boxes of Tut-Ankh-Amen who died about B.C. 1350.

EARLY developments of the mechanic arts of the Greek and related culture are found in Homer's *Iliad,* the story of the Trojan War (set as approximately B.C. 1193-1184), but written about two centuries after the event. The wheel was known to the Greeks, the Homerian heroes riding into battle in bronze-tired chariots. Doors and locks (of the sliding latch type) are described, too; the doors are similar to the earlier Egyptain models. There is evidence from the excavations of the Mycenean period (B.C. 1700) that such doors were perhaps seven centuries older than Homer. In Solon's time (B.C. 639-559) a vertical axis with four tablets fastened to it was used to display his laws; display stands with the same general features are still a part of our time, too. At about this time, the wooden ends or axles of larger doors were fitted with protecting sleeves of bronze, some being conical to reduce the frictional moment.

Homer also speaks of the strong bows of his heroes; these bows had the familiar flexing limbs. At some unknown later time the crossbow appeared; its string was pulled back by one arm, held mechanically in firing position, and mechanically released. This was a great forward step, for the weapon could not only be held in the cocked position, but the aim was much improved because of the stock.

This was also the time of the first Olympiad, at least the first in which the name of the victor was recorded. It was held in B.C. 776, with a foot-race of about 200 yards constituting the only event. Then, as now, the competition was entirely amateur (!), although in the old days the victors did "enjoy fixed revenues for life at the public expense." The Olympic games, held at four-year intervals, were originally patriotic, religious and athletic festivals. They degenerated because of professionalism and trickery, becoming so rotten under the Romans that a royal decree put an end to them in 394 A.D. They were revived on a world-wide basis and with many more events in 1896; the four-year cycle has been twice interrupted by wars.

By the 4th century B.C., a crossbow requiring a man's full strength to cock is found. Here the man pulled the string up with both hands while holding the bow down by pressing on the stock with his abdomen. The string was held at cock by means of a ratchet or catch, and released with a lever. In another crossbow, mentioned by the war historian Biton of Alexandria (about B.C. 250), the draw was accomplished by means of a winch; a 6 or 7-foot arrow was shot. Obviously the rate of fire was reduced even though the range and power were increased.

From the man-held weapon a number of larger devices were developed for throwing not only arrows but also rocks up to perhaps 60 pounds in weight. The King James version of the Bible ascribes the invention of such machines to the Jews under King Uzziah in Chronicles II, 26-15: "And he made in Jerusalem engines, invented by cunning men, to be on the towers and upon the bulwarks to shoot down arrows and great stones withal." This battle occurred in the 8th century B.C., but it is felt that the chronicler, who lived in the 3rd century B.C., modernized his story when he wrote it, for a number of other events indicate that it was not until the beginning of the 5th century B.C. that artillery[1] as such was worked on seriously. It was then that Dionysius the Elder (The Tyrant of Syracuse) is said to have imported engineers from Greece and Italy for development work on weapons for defense against the Carthaginians.

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[1] In the battle of Kardesh, the Hittite king sent 3500 chariots, each carrying three men, against Ramses. Such chariots were pulled by two horses.

The artillery or throwing engines did not make use of flexed bowlimbs but derived their propelling force from skeins of fibers (hair) or sinew that during the cocking operation were twisted to store energy. Some were fitted with a ratchet device to allow prestressing of the skeins. These machines were of two forms: (1) the ballista, looking something like an enormous crossbow, having a "bowstring" driven by two arms each thrust through a torsion skein, and usually shooting a heavy arrow, and (2) the catapult, having a single arm thrust through one skein and moving in a vertical plane, and carrying a stone at its free end which was released when the arm reached a nearly vertical position. For field warfare, these engines were fitted with wheels and axles. Philo (2nd century B.C.), the oldest known artillery historian, gives a formula[2] used by the engineers of Alexandria to proportion the diameter of the hole for the skein of torsion fibers to the weight of the projectile.

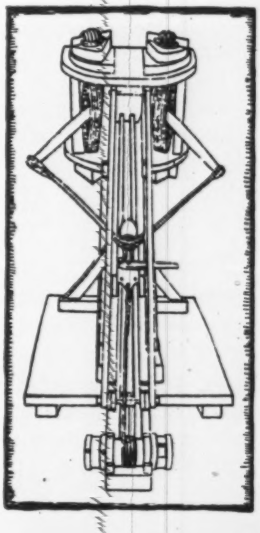
Philo considers the polybolon (we would call it a repeating weapon) invented by Dionysius of Alexandria to be a high point of development. Here a crank drove an endless chain that cyclically pulled back the bowstring; at the same time an arrow from a funnel-like magazine fell onto a horizontal roller having longitudinal grooves. Turning of the crank not only brought the bowstring into position but also revolved the arrow into firing position, and the weapon finally discharged on more cranking. This machine required only one man for operation, being mounted on a stand.

NOT all developments were associated with weapons. Gears—wheels with very obvious teeth of inserted pegs—seem to have been invented on the domestic front, in old Egypt at an uncertain age. They were used in water-raising and other hoisting devices. In the common form there was a large "crown" gear on a vertical spindle that mated with a lantern pinion on a horizontal shaft, the latter being also the winding shaft. The vertical spindle was fitted with a projecting bar or beam whose outer end was walked around in a circle by man or animal power. The modern form in 19th-century Europe, when powered by a horse, was called horse-gin in the rural areas of England.

Fluid-pressure devices were put to use in antiquity. Siphons are shown emptying liquids from big jars in Egyptian reliefs of about B.C. 1500. By the 3rd and 2nd centuries B.C., cups holding a constant level, altar figures pouring liquids, whistling birds—all siphon operated—were in quite common enough use. Ctesibius, in this third century, wrote a systematic work on "pneumatics," which was elaborated on by his pupil Philo of Byzantium.[3] There is a suggestion that a vacuum pump, similar to the bilge pump used in today's small boats, was also in use. However, Ctesibius did invent a single-acting force pump or syringe; it was described as a fire extinguisher by Hero in the 1st century A.D. in his treatise on pneumatics. This form of pump was widely deployed over the territories that the later Romans colonized. Like most things of the period, the design of these devices was based on empirical methods, for the nature of atmospheric pressure was not understood until the middle of the 17th century.

An ancient method for raising or lowering large weights made use of fluid pressure—the pressure exerted by dry sand. If dry sand is confined as in an excavation, and the weight rests on the sand, then the ramming of more sand around the periphery of the weight will cause the weight to rise; the removal of sand will lower the weight. Native Egyptian labor still uses this method when the close quarters of a tomb do not permit block and tackle to be rigged. Some years ago, one of the authors saw a small railroad bridge girder span being lowered into position; the ends of the girder were supported on the dry sand contained in a box, the lowering being accomplished by removing sand through small holes cut in the side near the bottom. Current railroad track maintenance involves tamping the ballast to bring ties and track into alignment and grade.

When speaking of fluid mechanisms, we must distinguish between those operating with a free fluid or a confined fluid. Among the former are



The palintonon or "stone-thrower" as described by Philo, Hero and Vitruvius. Energy is stored in the skeins as the "bowstring" is winched back. Note the lever release for the string. (From Diels) water-wheels and their inverse, the paddle-wheel of boats. A fluid that is confined may be put under pressure and guided to transmit power to a distant place. What is called Pascal's principle (Blaise Pascal, 1623-1662)—"if the pressure at any point in an enclosed fluid is increased, it will be increased everywhere throughout the fluid mass by the same amount"—had been recognized in essence by Leonardo da Vinci (15th century). Pascal described the hydraulic press; in an example he speaks of one in which the ratio of the two piston areas is as one hundred to one. It remained for Joseph Bramah to perfect the hydraulic press in 1795. Bramah suggested the use of hydraulic pressure in 1802 for the transmission of other forms of power, but nothing came of this then. William George Armstrong invented the hydraulic crane about 1840, established a factory for the manufacture of various hydraulic machines, including elevators, and devised the accumulator.

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[1] Artillery, according to Webster: Missile engines and weapons as catapults, arbalests, slings, bows, etc., with their missiles.

[2] The formula involved a cube root!

[3] Byzantium was the ancient name of today's Istanbul. Under Constantine the Great, Byzantium came to be called Constantinople when it was made the capital of the Roman empire in 329 A.D.

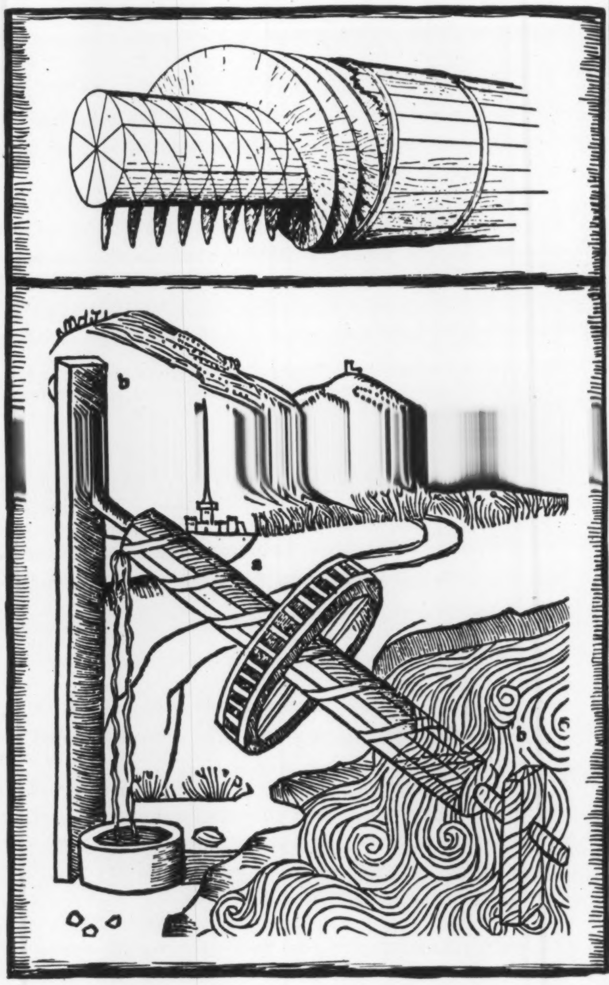
Today we think of power transmission in terms of electrical distribution systems reaching throughout cities and over the country. Yesterday the situation was different, for many cities (notably English) were supplied with hydraulic power systems. Thus, a system of hydraulic power transmission was established in London in 1883; by 1899 there were 106 miles of pipe (later extended to 150 miles!) carrying water at 750 psi, supplied by five steam-driven pumping stations whose total horsepower was 6100. About 3700 machines were connected, largely machines for intermittent work, as ram type elevators, punch and forging presses, balers—although a substantial number of Pelton wheels were used for rotary power. Manchester's hydraulic and electrical systems were both installed in 1894, but the heavy demand for hydraulic power soon necessitated a second pumping station. Both Manchester and Glasgow operated at 1000 psi.

In 1899 the city of Antwerp's first electrical [illegible] system consisted of a central pumping plant with pipelines radiating to "sub-stations" where the hydraulic power was converted to electrical for further distribution. Geneva's water power system dates from 1872, and the 3000 hp of 1900 had dropped to 340 in 1951. The equipment still connected at that time consisted of elevators, vacuum cleaners and 15 turbines, the latter being used in small factories, particularly in chemical plants, where electricity was considered hazardous in the manufacture of certain products.

Vacuum and compressed air systems were also tried as in Paris, before the electrical era. Compressed air is still available at 75 psi in some sections of Paris for operating elevators[1] furnaces, paint sprayers, etc.

Telodynamic systems (belt, rope or cable) for power transmission were used in France, Switzerland and India during the period 1860-1890. The power was taken from the river by means of turbines, and transmitted (distributed) up or along the bank by means of cables for distances of a mile or so—distances that were impracticable for shaft transmission. Pulley stands were located at intervals of 300-500 feet, and a single 1-inch steel cable could handle about 300 hp. The largest such plant had perhaps 3000 hp.

PHILO—to return to him and his weapons descriptions—tells of what might be called an air-operated bow. He called it an aerotonon, and it was invented, he says, by his teacher, Ctesibius (B.C. 300?-230?). It involved two cylinders fitted with pistons so arranged that a stressed leaf spring pressed each piston into its cylinder. On release of the spring the air was compressed, and the resulting piston motion was communicated to the bow arm. The arrangement was awkward, and a modern reconstruction (the text description is detailed enough to allow working drawings to be made) seemed to show the need for an external source of compressed air for satisfactory operation, although Philo claims to have seen the weapon operate successfully.



Top—Construction of the waterwheel of Archimedes.

The Archimedean screw turned by a water wheel. The original illustration was furnished to the edition of Vitruvius by Fra Goicondo, Venice, 1511. Compare the draftsmanship here with the drawings in Agricola. (From Vitruvius, the Morgan translation)

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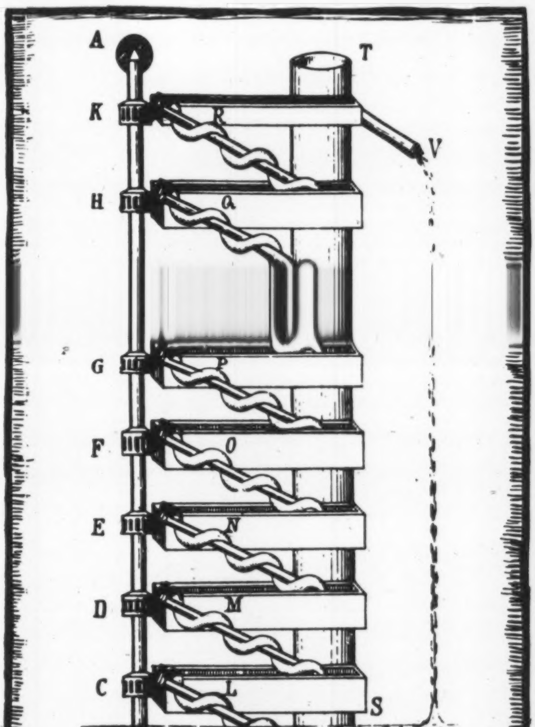
[1] This the authors know well from personal experience.

Aside from the attempted use of compressed air, the aerotonon had another technical innovation, the leaf spring. Previous metal springs looked somewhat like the modern safety pin, but the elasticity of metals had certainly not been exploited, and bronze was perhaps not the best choice of material. Philo does speak of the method of testing swords by flexing them, and noting that they suffered no permanent deformation. Nothing come of the idea of springs, however, for spiral springs do not seem to appear until the 15th century, with the reappearance of leaf springs being delayed until the later 16th century.

Aristotle (B.C. 384-322), his student Plato relates, discussed 38 problems of fundamental mechanics, among them the parallelogram of forces, the lever, wedge and circular motion. He recognized some of the basic principles in essence but not always clearly. The pulley, block and tackle, and pliers were devices in use at this time. Direction changing gears were no novelty to Aristotle. Aristotle worked in almost all fields—rhetoric, poetry, ethics, physics, politics, biology, metaphysics—and is also remembered as the tutor of the youth, Alexander the Great (B.C. 356-323) of Macedonia, who went on to the conquest of the then known world.

Alexander founded Alexandria; within a few decades it became the first city of Levant. Chief seaport of Egypt, it attained its greatest prosperity under the Ptolemies[1] (B.C. 323-30); Cleopatra, who nursed the adder to her breast, was the last of the line. The famous library was destined to become the richest of the ancient world, containing 490,000 volumes (some say 700,000) by the time the Roman siege under Julius Caesar in B.C. 48, when it was partly destroyed by fire. The library contained the collected literature of Rome, Greece, India and Egypt. Fanatic Christians completed the destruction in 391 A.D.



Water-raising machine of Augsburg, about 1550. The vertical shaft *AB* was driven by gears from a water wheel. The helical pipe arrangement is also known as the Archimedean screw. (From Treue)

THE scientific personality of the pre-Christian era about whom most is known is Archimedes of Syracuse (B.C. 287-212). The all-too-often told story that "Archimedes invented the lever" is now recognized as sheerest nonsense. Archimedes did concern himself with the law of the centrally supported lever, and even made a calculation on the length of a (weightless!) lever needed to move the earth provided he had a certain fulcrum, etc.

Archimedes contrived a mechanical device for moving a large ship. It is not certain whether the machine used was simply a block and tackle or whether a helix was involved: Plutarch and Athenaeus, in recounting the same incident (neither was an eye-witness), do not agree.

If the helix was used, then it was what is today called the worm gear. Reuleaux relates that Pappus (3rd century A.D.), in the latter's 8th Book (of the Collected Works of Pappus), quotes from the lost "Baroulkos" of Hero (1st century A.D.). Reuleaux shows two pictures of the worm-drive winch said to have been built by Archimedes. This winch, with spur gears on four shafts (the winding drum is on the last shaft), had its first gear driven by a "screw without end"—a worm or helix. The output was quoted as a force of 1,000 talents for an input of five applied to the crank of the worm shaft (a talent was about 57 pounds). A very early but careless translation of the Greek word helix into lever is said to account for the fable of Archimedes and the invention of the lever.

The ship is not without interest. According to Reuleaux, it appears that Archimedes' patron, King Hieron, had caused the *Syrakusia* to be built. She was the largest of her day, for the story is that she had three decks, three masts, eight towers fitted with throwing engines, and a weight of 4200 tons. Because of difficulties not minimized by the bronze fastenings and lead sheathing, the ship could not be brought to water. The winch was designed and successfully used after all ordinary means had failed to urge the ship down the ways. This would be the first gear-train of high accomplishment (the horse-gin type had wooden "gears" and was very crude when compared with the bronze gear and worm combination of Archimedes).

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[1] Ptolemy was one of Alexander's most effective generals.

The Greek biographer Plutarch (B.C. 46?-120?), in speaking of Marcellus, the conqueror of Syracuse, tells the story somewhat as follows: Archimedes wrote Hieron that with a small force he could move any great load—in fact, given another earth on which to stand, he could even move the earth! Hieron was skeptical, ordered that a freight ship be heavily loaded, and asked Archimedes to pull the ship up on land with the device of which he had written. Archimedes did the job with a block and tackle.

Regardless of what happened, the King was astonished, pleased and impressed, and commissioned Archimedes to build engines of war, later used against the Romans when Marcellus laid siege to Syracuse.

A water-raising device came to Archimedes' attention while he was on a visit to Egypt. This, now known as the Archimedean screw, came to be widely employed as a ship's pump. In its modern form it is known as a screw-conveyor; in its older form, the helix and external cylindrical casing were one and turned as such, the axis of the whole being inclined. A variant, also called the screw of Archimedes, has a pipe wound as a helix around an inclined shaft. Vitruvius,[1] a couple of centuries later, gives rather complete directions for the layout and construction of the first type; "the screw is turned by the treading of men" if no stream could drive a connected water wheel. The recommended inclination was three vertical and four horizontal.

The evidence seems to show that this type of pump was independently invented in Spain at about the same time that the Greeks developed it. Archimedean pumps, 90-130 cm long, are still used in the Nile delta, and have only recently disappeared from the European scene.

Archimedes' shrewd observations in the field of statics[2] do not concern us here. The Romans under Marcellus laid siege to Syracuse for two years before they took the town. It was Archimedes who organized the defense, built projectile throwing engines[3] and ship-destroying devices, as well as the apochryphal burning glass and steam cannon. The effectiveness of these devices was such that direct attack was abandoned, a blockade forcing the capitulation. His death at the hands of an over-zealous Roman soldier was mourned by Marcellus, who caused all honor to be given Archimedes' relatives. Even so, he was soon forgotten. His memory was revived to the Syracusans by the Roman Cicero (B.C. 106-43) who uncovered the neglected grave 137 years later and remarked that Archimedes possessed more genius than was compatible with the nature of man.

This account will be resumed in a future issue. The third and concluding chapter will contain an annotated bibliography including sources of illustrations appearing in this article.

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[1] Vitruvius Pollio (born B.C. 85 or 75) was architect, military engineer and inspector of military engines under the Roman emperor Augustus.

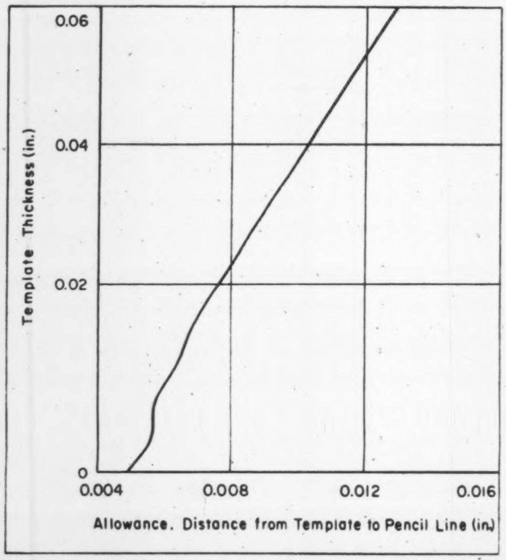
[2] For example, the principle of floating bodies.

[3] Some of these machines are said to have thrown stones weighing nearly 600 pounds.

Tips and Techniques

Accurate Repetitive Drawing

When a drawing must be duplicated many times with high accuracy, a template is usually constructed. Because errors in the drawing can be introduced by pencil-point thickness and template thickness, use the allowances given in the accompanying curve in the construction of the templates. The conical point angle on the pencil is assumed to be 15 degrees. In drawing, care must be taken to hold the pencil at right angles to the paper. — CARLOS L. BEECK, *Rosemead, Calif.*



Finding Screw Diamaters without Tables

Hunting for screw outside diameters in tables can be eliminated for the numbered screw sizes from No. 0 and up by remembering a simple relation. Since standard screws are increments of 0.013-in., take the screw number size, multiply by 0.013 and add 0.060. The result is the screw OD in inches.

For example, a No. 0 screw is 0.060-in. maximum outside diameter. Outside diameter of a No. 8 screw is found to be 8(0.013) + 0.060 = 0.164-in. —EDWARD P STARK, *Airborne Instruments Laboratory, Mineola, N. Y.*

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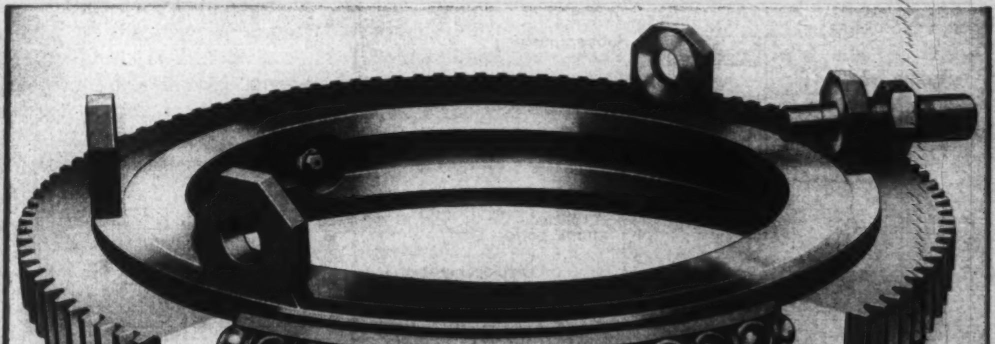
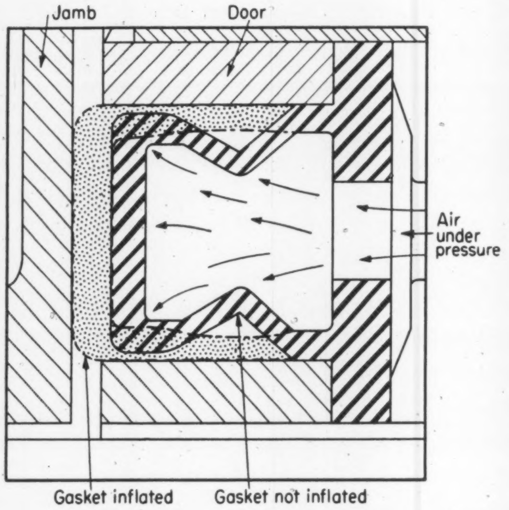
scanning the field for Ideas

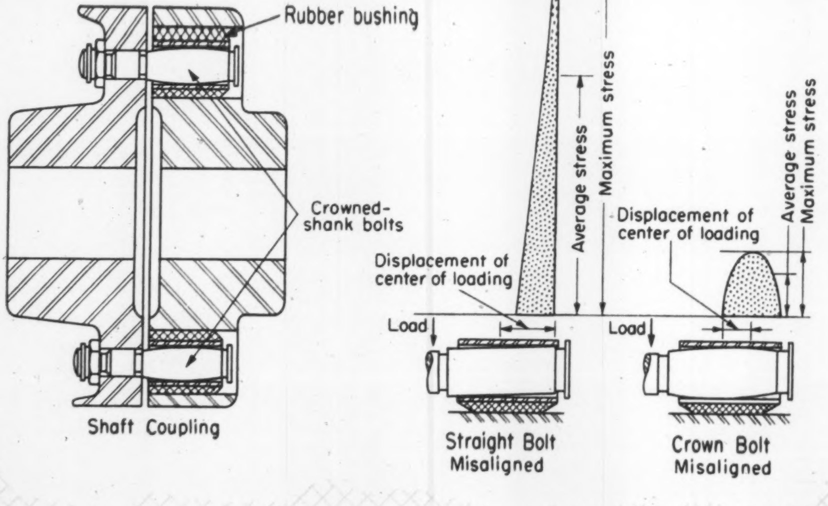
"SHEAR-BALL" MOUNTING technique for heavy-duty turntables eliminates need for top or hook type rollers, exposed roller paths, center pins, and centering gudgeons. In the design of shovel cranes, built by the Thew Shovel Co., a continuous circle of hardened-steel balls provides positive attachment of the stationary member to the rotating member. The balls are sealed in a hardened, precision-ground race made up by the two members. Of course, the balls also provide the rolling surface for revolving inner and outer members with respect to each other. The balls, which are admitted to the race through a plugable opening in the inner member, absorb vertical, horizontal and radial loads.




Jamb
Door
Air under pressure
Gasket inflated
Gasket not inflated

POSITIVE SEALING is assured in a pneumatically operated gasket design. Developed by the Continental Rubber Works for sealing doors to dampen noise in jet engine test cells, the rubber gasket is constructed to permit operation on an intermittent flexing cycle or as a continuous seal.

CROWNED-SHANK BOLTS minimize stresses caused by axial misalignment of bolts in holes. The bolts are employed in the construction of De Laval couplings for connecting rotating shafts which may be slightly misaligned. The crowned bolt distributes stresses over a greater area than a misaligned straight-shank design would. Also, surface compressive stresses are less in the crown design because the center of loading is displaced less under radial end loading.


Rubber bushing
Crowned-shank bolts
Shaft Coupling
Maximum stress
Average stress
Displacement of center of loading
Load
Straight Bolt Misaligned
Average stress
Maximum stress
Displacement of center of loading
Load
Crown Bolt Misaligned

A summary of basic factors in designing

Molded Plastic Parts

By Ralph E. Wallenbrock
Advance Design Engineer
International Harvester Co.
Evansville, Ind.

IMPORTANT factors which affect the design of plastic parts are the size, configuration and intended appearance of the end items. Economical production of plastic products is a fundamental consideration. Other factors are the structural aspects of proposed designs, mechanical practices in production and the kind of plastic used. This article provides a number of these basic considerations as a guide for designing plastic shapes.

Holes

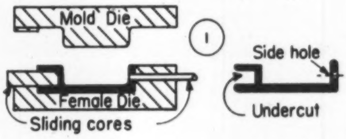
Side holes and undercuts can be created by cores that are removed by the operator or by mold parts that slide out of the way in cam fashion, *Fig.* 1. Side holes designed as slots, opening to the edge of a part, simplify production, *Fig.* 2.

Molded holes should have a ratio of length to diameter of 2½ to 1 or less for best construction. Long, narrow holes cause mold pins to bend or break, *Fig.* 3.

Generally, through holes are better than blind holes, *Fig.* 4. Blind holes should not be square at the bottom. A radius should be specified, *Fig.* 5.

Round holes are easier to make than square or any other shape, *Fig.* 6. Radii at hole corners are preferred to sharp corners, *Fig.* 7.

Where molded holes receive cut threads, countersinking should be specified to prevent feathering top threads, *Fig.* 8. External and internal threads may be molded with the part. Molded threads are generally more expensive to form and more apt to be weaker than other threads because a method of unscrewing the part from the mold must be provided, *Fig.* 9.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Female Die
Sliding cores
Side hole
Undercut

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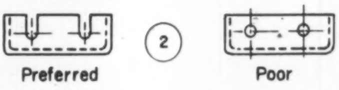
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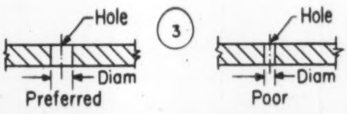
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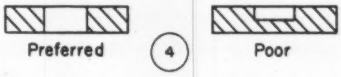
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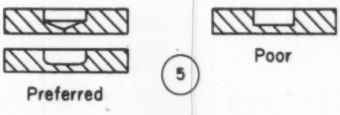
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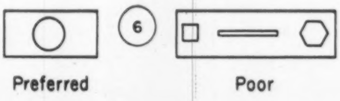
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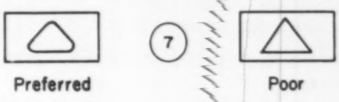
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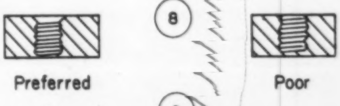
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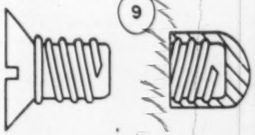

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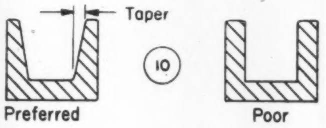
Taper

The exact amount of taper to specify depends on the molding process, wall thickness and material. Generally, taper is specified in degrees or in inches per inch, or in fractions of an inch per foot. A 3-degree taper is somewhat standard, *Fig.* 10.

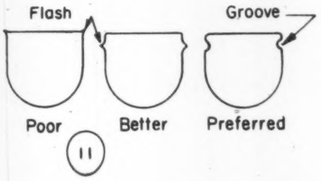


Tolerances

These vary widely with the type of molding and the material. Generally, injection or compression molded parts may be held close, but closer tolerances than necessary should not be specified. Tolerances for small parts amounting to ±0.002-in. per in. are possible on dimensions perpendicular to the direction of molding pressure but ±0.005-in. per in. is more practical. On overall dimensions parallel to the molding pressure ±0.005-in. can be held but ±0.010-in. is better. Plastic parts are dimensionally consistent as molded, but temperature changes effect overall size appreciably.

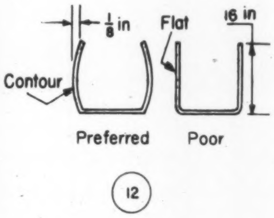
Flash and Parting Lines

Flash at the parting line of a mold may detract from appearance, *Fig.* 11. The parting line should be located so that flash can be polished off the finished part. Sometimes it is possible to mold or machine a groove where the parting line occurs. Gates are a similar problem. They should be located to be removed easily.



Contour

Contour is recommended on large areas, *Fig.* 12. Highlights on surfaces intended to be flat emphasize slight warping. Large, flat surfaces tend to look flat when the surface is actually convex. They tend to look concave when the surface is actually flat. Contour adds strength and reflects light in a more pleasant manner.



Flanges, Ribs and Bosses

Flanges add strength to a large wall area. They provide good locations for parting lines and they can be used for sealing and fastening, *Fig.* 13.

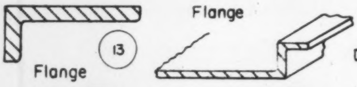
Flanges should have the same thickness as nearby walls of a part. Flanges which require undercuts in the mold should be avoided. Flanges should be used liberally, for they help prevent warping when parts are removed from a mold.

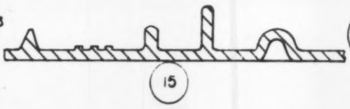
Ribs may be used to make large unsupported surfaces rigid. They may also serve as runners to ease the flow of plastic to isolated sections.

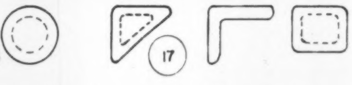
Where ribs or bosses are placed on the inside surfaces of thin translucent walls, it may be necessary to add decorative ribbing on the outer surfaces in order to conceal flow lines and shadows. It is often better to provide two small ribs in place of one large rib, *Figs.* 14 and 15.

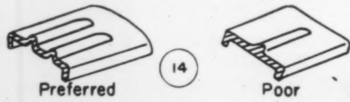
Bosses can be used to add structural support to plastic parts, *Fig.* 16. Bosses are usually specified around holes and inserts. The simplest boss is a raised area permitting the wall thickness to remain the same.

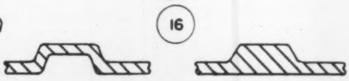
Bosses may have a variety of shapes, *Fig.* 17. They should not be confused with ribs or striations. Extremely heavy boss sections cause difficulty in filling the mold and cooling finished parts. Bosses should have generous radii to facilitate material flow. Sometimes bosses are tapered or faded into a flat plane surface. Bosses may be cored, drilled, tapped or threaded and they may contain inserts. Serving like a boss, a rim at the bottom of a cup helps prevent scratching, *Fig.* 18.

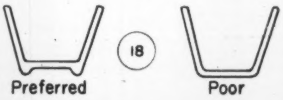










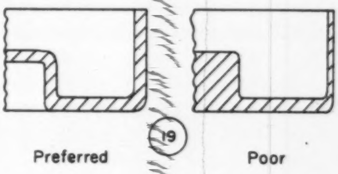


Wall and Section Thickness

Thickness of walls depends upon the kind of plastic material and the conditions under which the part is to operate. The walls should be as thin as practicable for lowest cost. Walls of uniform thickness prevent uneven shrinkage and resultant internal stress, *Fig.* 19.

The wall thickness of compression molded parts should not be less than 1/16-in., and for injection molded parts, not less than 0.050-in.

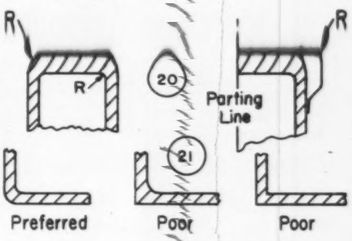
Abrupt changes in section thickness should be avoided because molding time depends on the thickest section, and because shrink marks may appear on surfaces of thick sections.



Fillets and Radii

Fillets at the base of ribs and bosses and on inside corners facilitate the flow of plastic and reduce the concentration of stresses at these points, *Figs.* 20 and 21. Fillets at the base of small protruding pin-type inserts reduce bending and breakage of the inserts.

A 0.015-in. radius at edges prevents chipping and reduces mold cost. Large radii off bosses and ribs strengthen those projections. Spherical corner radii are desirable. Contour radii help prevent warping and improve the appearance of large flat areas. Small radii should be specified at the ends of ribs or runners.



Inserts

One method of fastening molded plastic parts is with metallic inserts incorporated in the part at the time of molding. Inserts can eliminate the handling of small parts in subsequent assembly operations. However, inserts present problems in molding. They require a means of support in the mold and the loading of inserts increases molding cycle time.

One group of inserts includes mechanical parts around which plastics are molded for such purposes as improving the appearance of a product, providing a surface which is comfortable to touch, or insulating heat-conducting surfaces. The design of these inserts is based on the functional requirement of end assemblies. Where heat is not a factor, the thermoplastic materials are commonly molded around inserts of this group for decorative purposes.

In applications which involve vibration, or where high torque and axial force must be resisted, a metal insert with self-tapping threads is suitable. The insert is turned into a cored hole having the tap drill size for the thread of the insert, *Fig.* 22.

Delicate inserts should be avoided, especially in parts which are compression molded. The insert may bend or break off during the closing of the mold. When properly supported in the mold, delicate inserts may be used when parts are molded by the transfer and injection methods. Whenever possible, inserts should be designed so that both ends can be supported firmly in the mold.

Inserts should be located at right angles to the parting line to simplify mold design. Preferably, all inserts should be placed on the same side of the parting line.

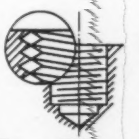
Inserts should be designed to have good anchorage in the molded part, *Fig.* 23. A diamond knurled surface provides good anchorage since the insert will withstand both tension and torsion loading. Grooved inserts, except those of hexagonal stock, accommodate tension loading only. Serrated inserts withstand only torsion loading. Inserts may be designed to have both grooves and knurled or serrated surfaces. Various methods of anchorage can be used.

To facilitate the flow of plastic and to reduce stresses caused by shrinkage of the plastic, the ends and grooves of inserts should be chamfered or rounded.

The shank of a protruding type insert should be of such length that the insert can be held securely in the mold, thereby preventing floating and misalignment of the insert.

Where it is necessary to apply heavy initial loading to inserts, such as tightening a nut on a stud, the embedded portion of the insert should have sufficient bearing area to support the load, *Fig.* 24.

Inserts can be used both as a means of fastening and as a part of an electrical circuit. An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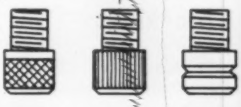
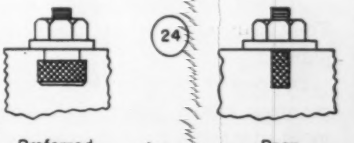




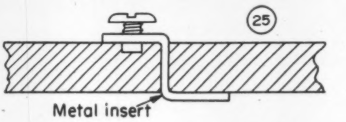
Inserts *(continued)*

insert used to fasten a molded part to another part may be an internal threaded hole, a protruding external threaded shank, a tubular rivet head, a protruding pin or a socket, *Fig.* 25.

The protruding portion of an insert should be round. This design is easier to clean of flash, and its corresponding hole in the mold is less expensive to form than holes of other shapes.

The cleaning of flash from knurled, protruding, pin-type inserts is simplified by providing plain shoulders of at least 1/32-in. length at the end of the embedded portion next to the plastic surface. A stepped shoulder provides the best seal against the flow of plastic.

Through-hole inserts which do not extend all of the way through a part or wall should be avoided. They are difficult to seal from flash with core pins. A closed-end insert blocks the passage of plastic into the threaded length, *Fig.* 26.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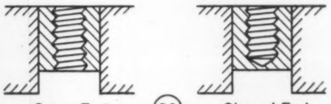

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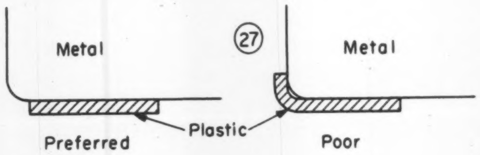
Matching Contour

Matching the contours of mating parts is very difficult and should be avoided. Intentional mismatching is often a good alternative, *Fig.* 27.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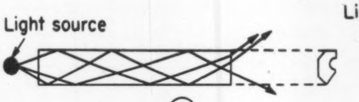
Light Transmission

Clear acrylic or clear polystyrene plastic can be used to transmit light. The principal surfaces of the plastic should be parallel or divergent for most efficient light transmission, *Fig.* 28. Any cross-section is satisfactory. If the principal surfaces converge, the incident angle is reduced at each reflection by the size of the angle between the surfaces. When the incident angle exceeds 42.2 degrees, the ray escapes, *Fig.* 29. Light can be directed along an irregular path. The nature of the beam leaving the plastic depends on the method of transmission, *Fig.* 30.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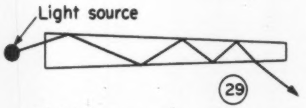
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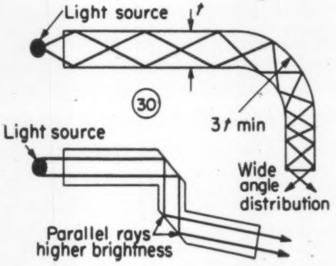
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Mechanical Finishing Methods

After removal from the mold, plastic parts can be trimmed and machined. Mechanical finishing operations include:

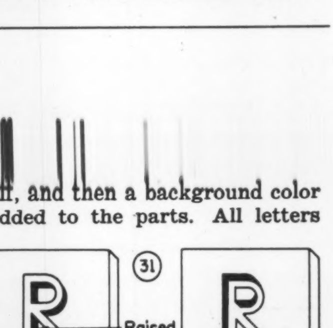
- Sanding—wet and dry
- Ashing and lapping with cloth disks
- Polishing with muslin
- Tumbling for flash removal.
- Solvent polishing for high gloss

Trimming can be performed with saws, sanders and shears. It should be held to a minimum, however, since it adds to total cost. A molded part well designed will require only a deburring operation to remove flash at parting lines. Sanding is not desirable either, since a sanded surface will appear dull and lusterless. Cleaning and polishing can be used to remove surface stains and scratches.

Markings

Lettering and other marking can be produced in plastics as depressed or raised characters. They can also be stamped or painted.

Depressed lettering in a piece requires raised lettering in the mold (intaglio). Less expensive raised lettering on the plastic piece is produced by engravings in the mold, *Fig.* 31. Recessed or depressed lettering is common on nameplates because of the painting, reflective, or pattern effects. Paint can be sprayed into the letter, wiped off, and then a background color added to the parts. All letters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in the same composition should be in one plane and no deeper than 40 per cent of section thickness.

The letters need not be raised more than 1/64-in. in dark colored plastics for good readability. In light colored plastic a greater height may be required. When letters are raised more than 1/32-in., taper and fillets should be provided for ease of removal from the mold and to eliminate damage to the lettering.

Letters and designs may be painted on smooth surfaces of molded parts. Before the operation, the surfaces must be clean and free of grease and oil. The adherence of paint may be improved by roughening the surface before painting. Where masks are used in spray painting their placement may be facilitated by incorporating a locating point on the molded part.

Markings may be formed on the surface of molded parts by a stamping die. The depressions are approximately 0.005 to 0.015-in. deep, depending on the size of the character and the kind of plastic. Where contrasting colors are desired, a special tape is inserted between the part and die. This process is also known as roll leaf printing.

A three dimensional effect is obtained where depressed letters and designs are molded on the back of transparent plastic parts which are subsequently coated with copper, chromium, silver, gold, bronze or colored paint.

Surface Treatments

If finished parts must be attractive, properties desired in the plastic are scratch resistance and surface hardness. Both are not always found in the same material. If an easily scratched plastic must be used, protective ribs and bosses may be located to receive the abrasion. Sometimes a special surface effect protects the plastic.

Illuminescence is achieved by adding phosphor dyes to translucent plastic. Luminous effects can also be obtained by painting plastic with a phosphor paint.

Vacuum metallizing is a common method of decorating and protecting plastic parts. There is no practical limit on the size of parts to be vacuum metallized. Metal finishes can be applied to either first or second surfaces of molded parts by means of vacuum deposition. The result is an effect of solid or plated metal parts.

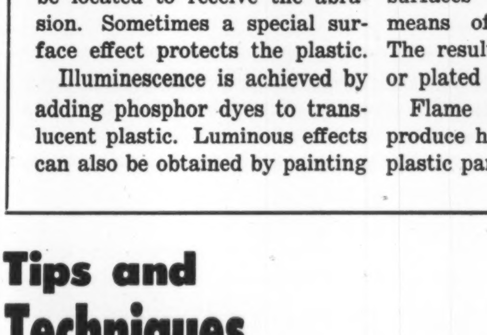
Flame polishing is used to produce high gloss on a molded plastic part. It consists of passing the plastic parts through a flame for a very short time so that the heat affects only the outer surface of the plastic. The technique is particularly suitable for thermoplastics. It is not widely used, however, because it requires close control and anneals the part.

Glass fiber effects are popular in styling. Distinctive textures can be produced on plastic surfaces by woven glass fiber. A variety of woven patterns can be obtained.

Tips and Techniques

Rapid Section-Line Drawing

A METHOD for rapidly drawing section lines is the use of a plastic, thin-wood or heavy illustration-board gadget, *A*. Starting at position 1, a section line is drawn. The gadget is then shifted to position 2 and held in place; the triangle is moved to the right; and the second section line is drawn. Even spacing is automatic, and the gadget can be cut to suit whatever spacing is required.—P. K. CHEAL, *Birmingham, Mich.*



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"Engineers graduating this year and next will be faced with many complex problems, and they will probably find that in some areas their preparation is inadequate. Because many developments now being used are not included in textbooks, it is vital that each young engineer realize that he will be forced to step up his study habits rather than try to ride on only his present information."—DR. MAYNARD M. BORING, *president, American Society for Engineering Education*

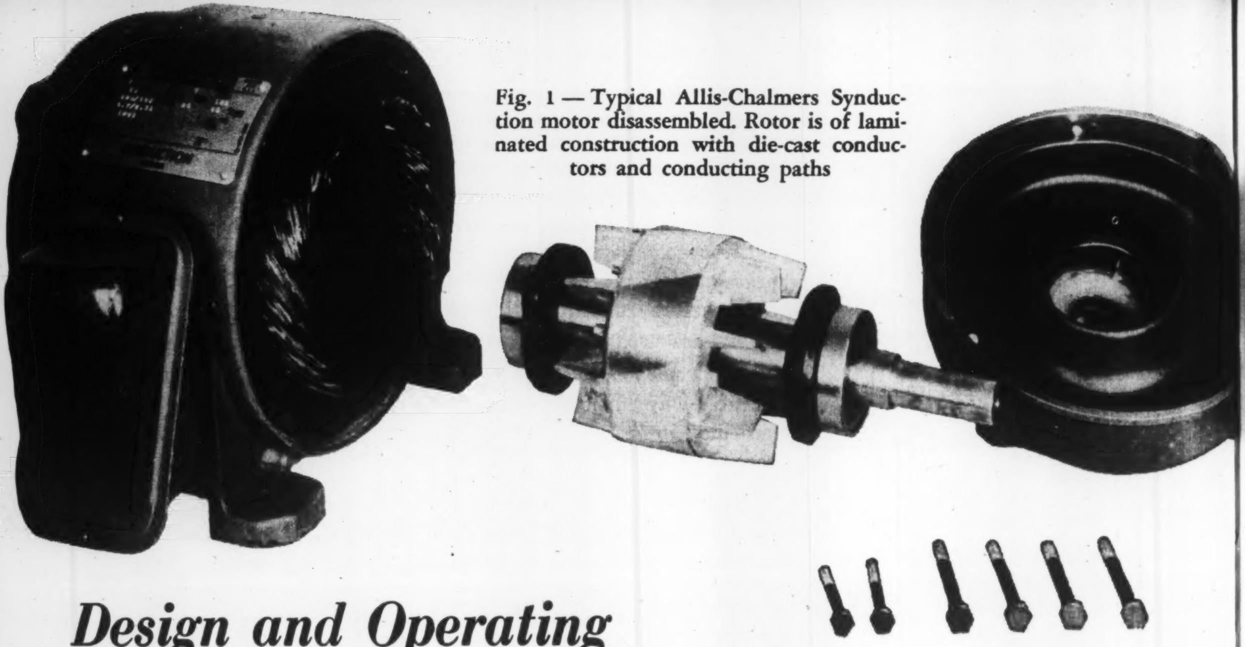


Fig. 1 — Typical Allis-Chalmers Synduction motor disassembled. Rotor is of laminated construction with die-cast conductors and conducting paths

Design and Operating Characteristics of a New Synchronous Electric

New ac motor design with die-cast rotor starts like an induction machine, but operates without slip from no-load to pull-out. Units are characterized by high operating efficiency, with simplicity of maintenance comparable to squirrel-cage motors. Available in horsepower ratings from ¼ to 40, these motors are built on standard induction-motor frames and enclosures. These drives can be operated at constant speeds or adjustable speeds by controlling input-power frequency. Several of these motors can be operated in synchronism when energized by a common power source. Cost is only slightly more than squirrel-cage designs.

MANY design situations call for an electric motor that will operate or can be held at a constant speed. One answer might be the conventional synchronous motor which runs at a constant speed if line frequency is constant regardless of changes that may occur in either load or line voltage. However, the synchronous motor employs windings on rotating field poles, and these windings require dc excitation through slip rings. A separate exciter unit is usually needed to produce dc excitation and, of course, dc exciters have commutators and brushes. As a result the relatively complex, expensive construction of the synchronous motor has generally limited its use to applications above 40 hp.

The industrial, polyphase induction motor is characterized by a rugged mechanical construction, particularly in the rotor, and it has a low first cost. The rotor windings are die cast, and there are no brushes or slip rings to create maintenance problems.

However, the speed of an induction motor varies with changes in load and line input voltage. In fact it is difficult to obtain two induction motors with the same nameplate ratings that will operate at exactly the same speed driving identical loads, even when operated on the same voltage and frequency.

Synchronous-Induction Design: By combining the design and construction characteristics of the synchronous machine and the induction unit, a basically new electric motor has been developed by Allis-Chalmers which is tradenamed Synduction.

This design may also be considered as a variation of the synchronous-reluctance motor. As shown in Fig. 1 the stator is like that of a typical squirrel-cage induction motor, and the rotor is made up of laminations with die-cast conductors including a squirrel-cage winding. The rotor magnetic circuit is designed to obstruct, to a major degree, the flow of quadrature-axis flux and simultaneously provide maximum flow of direct-axis flux.

Performance Characteristics: The Synduction motor starts and accelerates like an induction motor. The rotor, with the aid of induction-motor torque, is accelerated to a speed just below synchronism. Then, if the load inertia is within design limits, speed quickly rises to synchronism.

After acceleration as an induction motor, the unit runs at constant speed regardless of changes

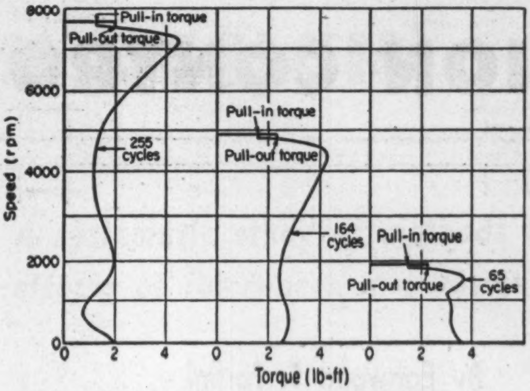


Fig. 2—Speed-torque curves for a typical Synduction motor operated on three different frequencies of input voltage. Motor data: 2.07/0.526 hp, 240/61.4 v, 255/65 cycles, 7660/1950 rpm; rotor inertia, 0.09 lb-ft²; load inertia, 0.2 lb-ft²

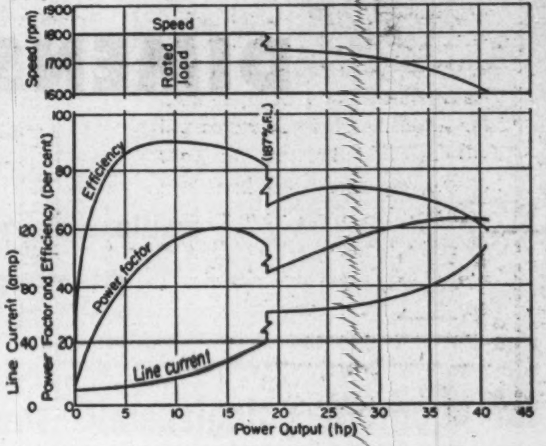


Fig. 3—Characteristic curves of speed, efficiency, power factor and line current for a 10 hp, 1800 rpm Synduction motor

Motor Drive

in load or voltage, provided the pull-out point is not exceeded and the supply frequency is held constant. Beyond pull-out the motor runs as a squirrel-cage induction motor; slip takes place and the speed decreases with load. The motor is not designed to operate beyond the pull-out point.

Design-Performance Relationships: The resistance of a squirrel-cage winding has a significant effect on the ability of a motor to synchronize. The lower the resistance, the lower the slip, and the closer the motor will approach synchronism as an induction machine. Hence, for good synchronizing ability it is desirable to have a low-resistance cage; this feature is inherent in this particular motor. Not only are the large quadrature-axis slots filled with aluminum to produce a low-resistance cage, but even the direct-axis slots are interconnected with large masses of aluminum.

Speed-torque curves for one model of the synchronous-induction motor operated at three widely different frequencies are shown in Fig. 2. For the curves in Fig. 2 the load inertia is 2.2 times that of the motor rotor and, for the three frequency conditions shown, the pull-in torque averages about 100 per cent. The range of values that may be expected for pull-out torques for eight different horsepower ratings are listed in Table 1. This pull-out value can be adjusted in the design stage of the motor but it averages about 175 to 200 per cent of rated torque.

Typical efficiencies and power factors at full-load for these eight motors are also shown in Table 1. Curves depicting efficiency, power factor, speed, and line current of a 10-hp Synduction motor are given in Fig. 3. These curves show performance both in the constant-speed operating range, (below pull-out) as well as beyond the pull-out point when the motor operates on induction torque. The transition between these two regions is the pull-out point. The transition is quite abrupt as can be seen by the curves. As the pull-out point is passed, the motor abruptly becomes noisy, and meter readings fluctuate.

The starting torque and current of the synchronous-induction design motors generally are greater than those of induction motors but less than those of former reluctance motors. Table 2 illustrates comparative performance characteristics for typical 20-hp motors for five different types of motors operating on 60 cycles. These relationships vary considerably at other horsepower ratings.

Table 1—Synchronous-Induction Motor Performance

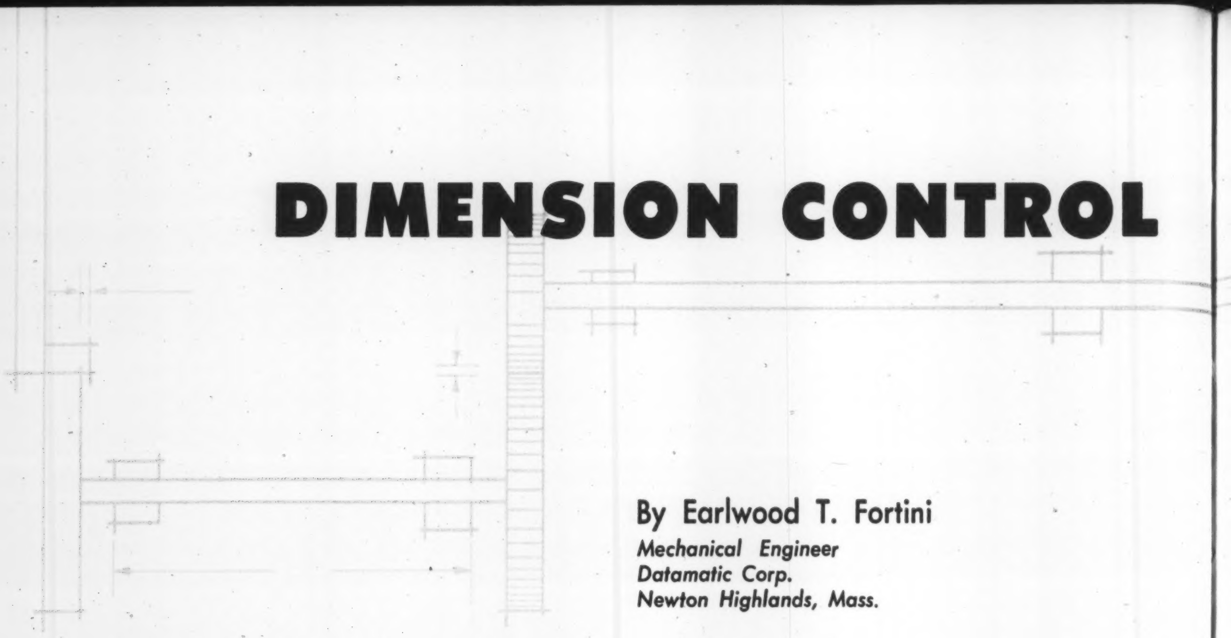
Power Rating* (hp)	No. Poles	Pull-Out Torque (% full load)	Full-Load Efficiency (%)	Full-Load Power Factor
½	4	210	68.0	61
1	4	181	73.0	53
1½	2	189	80.0	70
2	4	190	78.0	54
7½	4	176	87.5	57
10	4	187	90.0	56
30	6	166	90.0	62
50	6	163	91.5	61

*All ratings based on 60-cycle power.

Table 2 — Performance Characteristics of Five Types of AC Motors*

	Synchronous Motors (100% P.F.)	Synchronous Motors (80% P.F.)	Synduction Motor	Induction Motor	Reluctance Motor
Efficiency, %	88	87	88	88	79
Power Factor	100	80 (Lead)	60 (Lag)	88 (Lag)	38 (Lag)
Pull-Out Torque, lb-ft	150	200	175	..	150
Pull-In Torque†, lb-ft	110	125	120	..	80–100
Locked-Rotor Torque, lb-ft	110	125	280	150	400
Locked-Rotor Current, amp	675	600	975	575	1050

*Based on 20-hp, 1800-rpm, 3-phase motors.
†Based on 8 lb-ft² of load inertia.



DIMENSION CONTROL

By Earlwood T. Fortini
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Datamatic Corp.
Newton Highlands, Mass.

THE STARTING point for a dimension study is recognizing the problems in an individual design. Many different, often difficult, problems are found in the relationship of mechanical elements to forces, rates of flow, motions, and so on. Fits—the fitting together of mating parts—are another class of dimension problems, especially important because they occur so frequently.

Recognizing a problem may begin, for instance, by merely appreciating that the adjustment knob of an instrument must not feel sloppy, that a journal bearing must have clearance, or that a shaft should not have too much axial play.

Determining the factors that affect, say, the clearance of a journal bearing, will require an understanding of journal bearing design. In most fit problems the dimension condition depends only on design geometry.

Specifying the limits of a dimension condition may be the most difficult part of a dimension study. Performance is often a matter of judgment and opinion more than anything else. The backlash in the adjustment knob of an instrument, for example, may have nothing to do with the usefulness of the instrument—but may make a bad impression on a prospective customer. Allowable limits for backlash could be determined by experience or simple experiment, and the dimensions controlled accordingly. What is often wanted is not that a specific dimension condition be met, but that a judicious choice be made between tolerances and the variation of the dimension condition.

After dimension relationships have been formulated and the equations solved, the end result is the dimension limits for the manufacturing drawings. The purpose of this article and the next article in this series is to give methods for formulating these dimension relationships when dimensions are defined by limits only. Future articles will discuss similar concepts for probability-distributed dimensions, and will show how these methods can be used in practice.

Mechanism Trains: A machine or instrument can be analyzed as a system of one or more trains of mechanisms. Each train has a job to do. How it does its job can be expressed as a relationship between the input of the train and the output. This relationship is satisfied in the synthesis of the train—what each mechanism does in relationship to the whole train. The equation of train variation

Nomenclature

k = Constant
M = Combination of modifiers, m, affecting a particular variation, v (see Equation 5)
m = Modifier imposed on a unit in a train by the succeeding unit; in mechanism trains, the maximum absolute value of the first derivative of the succeeding mechanism function
N = Number of teeth in a gear; or diameter of the gear
n = Number of units being considered
v = Variation of a dimension condition; in a mechanism train, variation of the output of the complete train or of individual mechanisms
Y = Output function of an individual mechanism

Subscripts

j = Generalized number representing any individual unit in a group
max = Maximum
n = Number representing the last unit in a group
tr = Of a mechanism train
1, 2, 3 . . . = Numbers representing individual units in a group

IN DESIGN

A systematic study of methods for controlling effects of tolerances and design geometry

Part 3—Limit Dimensioning Methods for Analyzing Mechanism Trains

is derived from the function of each mechanism. The simplest train consists of a single mechanism.

The mechanism train shown in *Fig.* 20 will be used to illustrate the formulation of dimension relationships. It is assumed that the function of each mechanism can be put in the form of an equation; of course, this is not always possible. When it is not, the equation of train variation may have to be derived in whole or in part by a graphical method.

One would presume that to study variations in a mechanism train the shapes and sizes of many parts of the design must first be fixed. However, tentative studies based on guesswork, however crude, will usually reveal which parts of a mechanism are sensitive to variations and which are not. Attention can then be focused on a relatively small part of the design. An important part of this procedure is the technique for solving equations of variation in a train of mechanisms.

Synthesis of the Train: During the synthesis of a mechanism train, a designer may have the greatest opportunity for controlling train variation. Each mechanism in the train has an influence on the variation of all the preceding mechanisms; the cumulative variation at the output of the train can be made greater, less, or remain unchanged, depending on the function of the separate mechanisms. The train should be designed, if at all possible, so that cumulative variations are diminished. Two objectives will be realized: train accuracy will be high, and relatively liberal tolerances can be used for the component parts.

Some mechanism trains in a system may not be independent. In a lathe, for instance, part of the train that traverses the carriage is usually common with part of the train that rotates the

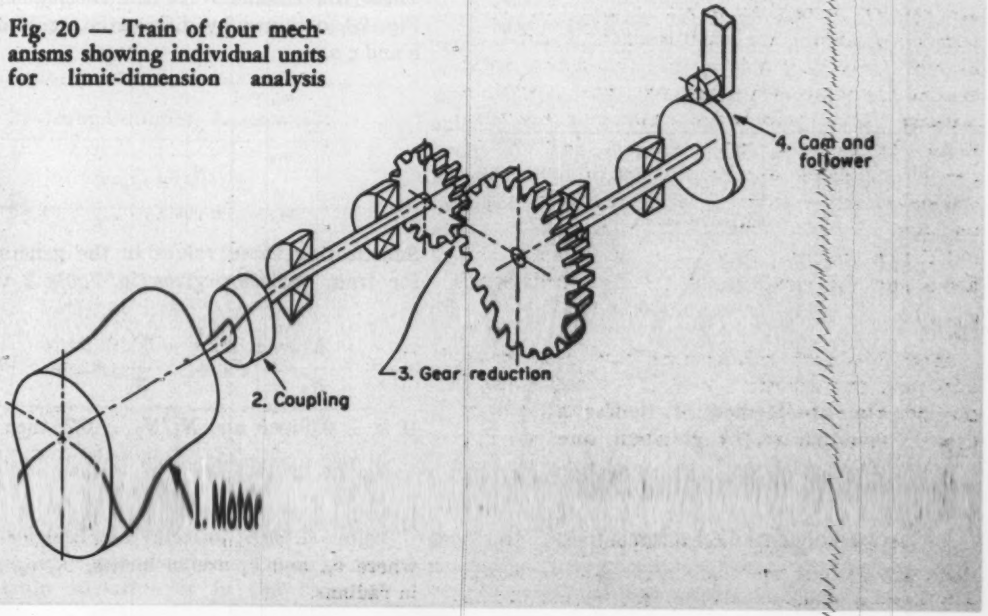


Fig. 20 — Train of four mechanisms showing individual units for limit-dimension analysis

spindle. In systems of interrelated trains, each train can be examined separately, disregarding the fact that some mechanisms are common with other trains. Variations of mechanisms common to two or more trains must be controlled to satisfy the requirements which are most severe.

A mechanism train is synthesized to satisfy some relationship between the action of the first mechanism, and the action of the last. Suppose a train consists of four mechanisms. The relationship between the action Y_1 of the first mechanism, and Y_4 of the last, is some function, $Y_4 = f(Y_1)$.

This function is not obtained directly, but is a consequence of the relationship between actions of the separate mechanisms: $Y_2 = f(Y_1)$; $Y_3 = f(Y_2)$; and $Y_4 = f(Y_3)$. These relationships can be called *mechanism functions*. Thus the mechanism function of the jth mechanism is $Y_j = f(Y_{j-1})$.

Suppose that the train shown in *Fig.* 20 were synthesized to satisfy the following relationship between the action of the first mechanism, the rotation of the motor, and the action of the last mechanism, the motion of the cam follower:

$$Y_4 = k \sin \left(\frac{N_1}{N_2} Y_1 \right) \qquad (4)$$

Suppose further that the mechanism functions from which this relationship is constructed are

$$Y_2 = Y_1 \qquad (4a)$$

$$Y_3 = \frac{N_1}{N_2} Y_2 \qquad (4b)$$

$$Y_4 = k \sin Y_3 \qquad (4c)$$

Numerical values will later be substituted for k and the ratio N_1/N_2. For the present it is more advantageous to use letter symbols.

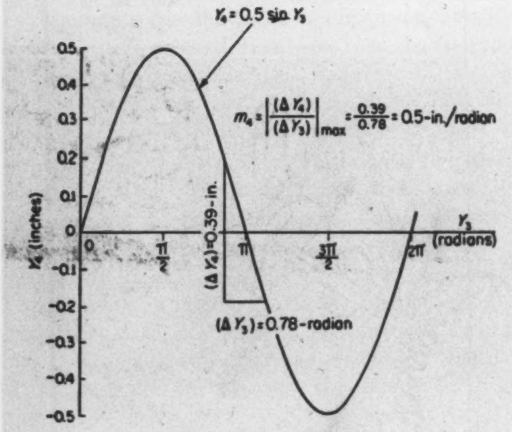


Fig. 21—Method of finding a modifier, *m*, by graphical construction of the function relating two individual mechanism outputs

Equation of Train Variation: Variation is a departure from an ideal condition—variation from the ideal clearance of a journal bearing or, in the case of the mechanism train now under consideration, variation from ideal motion of the cam follower.

Variation in the action of a single mechanism may not be a simple quality, but rather a complex combination of several distinct variations, each of which is the result of some particular cause. When the effects of variations in a mechanism train are considered, it is expedient to lump all the variations in any one mechanism together into a single mechanism variation.

Train variation is a combination of mechanism variations. The variation of the first mechanism is modified by the second mechanism, $m_2 v_1$. To this is added the variation of the second mechanism, $m_2 v_1 + v_2$. The sum is then modified by the third mechanism, $m_3 (m_2 v_1 + v_2)$; and to this is added the third mechanism, $m_3(m_2 v_1 + v_2) + v_3$. The process is continued until all of the variations are included in one formula.

Expressions for train variation derived by this process can be expanded and put in a more useful form. *Table* 2 includes formulas for trains of from two to five mechanisms. A general formula obtained by induction is

$$v_{tr} = M_1 v_1 + M_2 v_2 + \ldots + M_j v_j + \ldots + v_n \qquad (5)$$

where

$$M_j = m_n m_{n-1} \ldots m_{j+1}$$

Modifiers are the maximum absolute values of the derivatives of the mechanism functions:

$$m_2 = \left| \frac{d Y_2}{d Y_1} \right|_{max}$$

$$m_j = \left| \frac{d Y_j}{d Y_{j-1}} \right|_{max}$$

Thus, the modifiers for the mechanism train of *Fig.* 20, obtained by differentiating Equations 4*a*, *b* and *c* are

$$m_2 = 1$$

$$m_3 = \left| \frac{N_1}{N_2} \right|$$

$$m_4 = | \, k \cos Y_3 \, |_{max} = | \, k \, |$$

Substituting these values in the general equation for train variation given in *Table* 2 yields

$$v_{tr} = \left| \frac{N_1}{N_2} k \right| v_1 + \left| \frac{N_1}{N_2} k \right| v_2 + | \, k \, | \, v_3 + v_4$$

If $k = 0.5$-inch and $N_1/N_2 = 0.2$, then

$$v_{tr} = 0.1 \, v_1 + 0.1 \, v_2 + 0.5 \, v_3 + v_4 \qquad (6)$$

where v_{tr} and v_4 are in inches, v_1, v_2, and v_3 are in radians.

If each mechanism in the train were allowed to contribute equally to the train variation, then it is apparent from Equation 6 that the motor and coupling could each be permitted a variation five times that of the gear reduction, or ten times that of the cam and follower.

Graphical Methods: It may not always be possible to write mechanism fuctions in the form of equations from which the modifiers may be derived. Such is the case, for instance, when a mechanism train is synthesized to satisfy actions represented by graphical or numerical data. Numerical data can usually be plotted so that graphical methods may be used, although in some cases it may be advantageous to use numerical methods directly. Numerical methods, however, will not be discussed in this article.

The action of the cam and follower is shown graphically in *Fig.* 21. This is the same function that is given in Equation 4*c* with $k = 0.5$-inch. Obtaining the value of the modifier by the graphical method requires constructing a tangent to the steepest part of the curve to obtain the maximum absolute value of the derivative. After (ΔY_8) and (ΔY_4) are measured, the modifier may be calculated:

$$m_4 = \left| \frac{(\Delta Y_4)}{(\Delta Y_3)} \right|_{max} = 0.5\text{-inch/radian}$$

which is identical with the value of m_4 obtained by mathematical differentiation of the mechanism function.

Solving Equations of Train Variation: Equations of train variation can be solved in one of two ways. The simplest is to assign reasonable values to the mechanism variations and check to see if the resulting train variation is also a reasonable value. This is a logical course to follow if no definite value for train variation is demanded. But when train variation is a particular value, the solution of the equation is not straightforward. Before the equation can be solved, some assumption must be made controlling the relative effect of each mechanism variation on train variation.

Table 2—Train-Variation Equations

Number of Mechanisms	Train Variation, v_{tr}
2	$(m_2)\ v_1 + v_2$
3	$(m_3m_2)\ v_1 + (m_3)\ v_2 + v_3$
4	$(m_4m_3m_2)\ v_1 + (m_4m_3)\ v_2 + (m_4)\ v_3 + v_4$
5	$(m_5m_4m_3m_2)\ v_1 + (m_5m_4m_3)\ v_2 + (m_5m_4)\ v_3 + (m_5)\ v_4 + v_5$

One assumption is that each mechanism should have equal effect on train variation; this is called the assumption of equal weights. Thus, if the equation of train variation is in the form of Equation 5, each term has equal weight when

$$M_1\,v_1 = M_2\,v_2 = \ldots = M_j\ v_j = \ldots = v_n$$

and so

$$v_{tr} = n\,M_j\,v_j \qquad (7)$$

from which all the values of the mechanism variations may be obtained. Note that when solving for v_n, $M_n = 1$.

For example, if in Equation 6 the train variation is 0.005-inch, then values of the mechanism variations for the assumption of equal weights are: $v_1 = v_2 = 0.0125$-radian, $v_3 = 0.025$-radian. and $v_4 = 0.0013$-inch.

The assumption of equal weights is not the only basis for solving an equation of train variation. Instead of the values for individual mechanism variations given in the above example, it may be better to have v_4 larger by making v_1 and v_2 smaller, thus obtaining a more economical division of train variation among the four mechanisms. Consider the premise that

$$v_n = v_j\,\sqrt{M_j} \qquad (8a)$$

which may be called the square root assumption. Then

$$v_{tr} = v_n\,(\sqrt{M_1} + \sqrt{M_2} + \ldots + \sqrt{M_{n-1}} + 1) \qquad (8b)$$

When using the square root assumption, first solve Equation 8*b* for v_n, and then compute the remaining values of mechanism variation by means of Equation 8*a*.

If the square root assumption is applied to Equation 6, again for $v_{tr} = 0.005$-inch, then $v_1 = v_2 = 0.0066$-radian, $v_3 = 0.0030$-radian, and $v_4 = 0.0021$-inch. Compare these values with those obtained for the assumption of equal weights.

From the previous examples it would seem that when the coefficients of the variations differ by a considerable amount (as they do in Equation 7) the square root assumption gives better results than the assumption of equal weights. But the square root assumption should not necessarily be considered the ultimate. Other methods for solving equations of train variation may be more suitable, depending on the circumstances. Moreover, any method of solution will often require special adaptations to particular problems. For instance, if the coupling in *Fig.* 20 were a standard item with a predetermined variation, then Equation 7 would have to be modified as follows,

$$v_{tr} - M_2\,v_2 = (n - 1)\ M_j\,v_j;\ j \neq 2$$

and similarly for Equation 8*b*

$$v_{tr} - M_2\,v_2 = v_n\,(\sqrt{M_1} + \sqrt{M_3} + \ldots + \sqrt{M_{n-1}} + 1)$$

Next Article: Part 4 of this series will discuss simple dimension systems—how to analyze individual mechanisms and assemblies to find sources of variations with limit-dimensioning analysis.

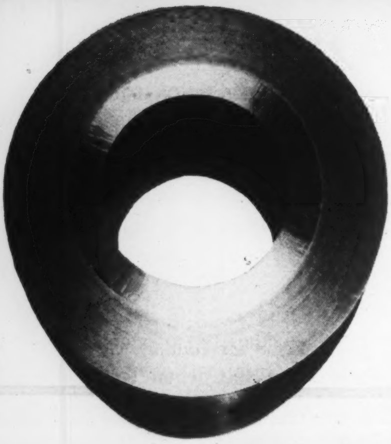
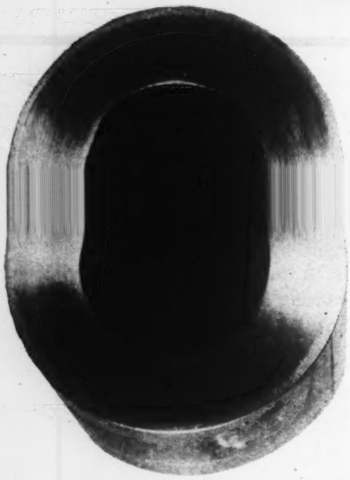


Fig. 1—Left—Cross section of stainless clad steel pipe made by centrifugal casting of Type 347 stainless steel on inside and $2\frac{1}{4}$ Cr, 1 Mo alloy steel on outside

Fig. 2—Below—Cross section of copper clad pipe made by "compressing" copper tube around smaller diameter steel pipe

Welding Composite Steels:



By Helmut Thielsch
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COMPOSITE steels are either clad steels or applied liners. Both are made of a mild or low-alloy "backing steel" to which another metal or alloy is bonded on either or both surfaces. Composite materials combine desirable properties of the cladding material with the strength or forming characteristics of the backing steel, and they may offer cost savings over the use of solid materials.

In a clad steel the bond is continuous over the entire surface area. Clad plates are always referred to as *clad* but clad piping is frequently called *dual metal*.

Applied liners consist of sheets or relatively thin plates bonded intermittently by welding to the backing steel.

In most applications, clad steels or liners are selected for their corrosion resistance in environments which would attack mild or low-alloy steel. There are also many applications where composite steels are selected for their heat conductivity, oxidation resistance, wear resistance, and other characteristics.

Although numerous cladding and liner combinations are possible, the greatest tonnage produced is stainless-clad steels or stainless-steel applied liners. Pressure vessels, particularly, use solid stainless plate or a stainless composite plate. Which kind to specify depends upon the cost of the plate in the thickness needed and upon production, design and fabricating considerations. For chemical pressure vessels and tanks, solid stainless-steel plates generally are most economical in thicknesses up to about 3/16-in.

In the wall thickness range from approximately 3/16 to ½-in. solid stainless steel and stainless clad steel are competitive. If consideration is given only to the higher allowable stresses permitted by the ASME Boiler and Pressure Vessel Code for the solid stainless steels, their use would be more economical than stainless steel clad to mild steel. However, when higher-strength alloy steels are used as backing components, the difference between the allowable stresses of the clad and solid materials can be reduced or reversed.

In storage tanks, processing tanks and similar

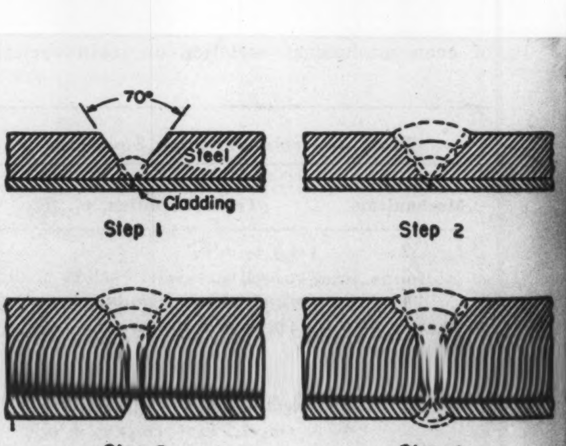


Fig. 3—Recommended procedures for welding clad steel joints over ⅛-in. thick accessible from both sides

CLAD STEELS

There are two kinds of composite steels—clad steels and applied liners — each with specific advantages. This article compares the two briefly and summarizes the welding of clad steels. A later article will consider the welding of applied liners.

vessels, where stiffness or rigidity are of primary importance, clad steels may be more suitable than solid stainless steels. When heat transfer and good corrosion resistance are desired, the clad grades have a definite advantage over solid stainless steels because of the higher heat conductivity of the mild backing steel. Hot working and forming operations are usually more costly for solid than for clad stainless steel.

For wall thicknesses between about ½ to 1¼ in., stainless-clad steels and stainless applied liners are competitive. In pressure vessels and tanks, clad materials are usually preferred up to ¾-in. In thicker walls, liners are more commonly used.

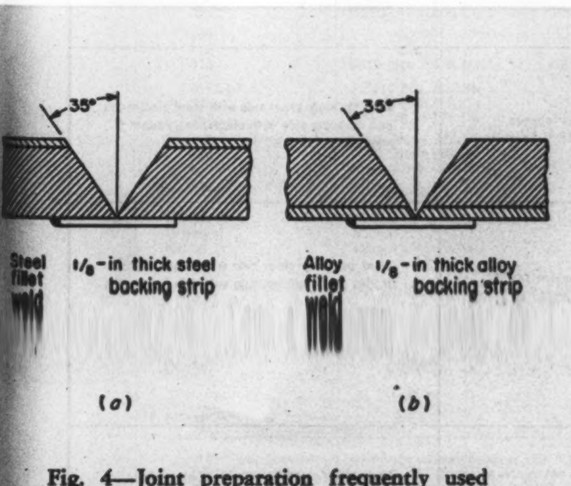

35°
35°
Steel fillet weld
1/8-in thick steel backing strip
Alloy fillet weld
1/8-in thick alloy backing strip
(a)
(b)

Fig. 4—Joint preparation frequently used for welding blind joints: *a*, steel side blind; *b*, clad side blind

Above 1¼ in. the attachment of liner plates to the backing steel is likely to be most economical if fabricating and operating conditions permit their use.

There are significant differences between the welding of clad steels and the welding of applied liners. Handling, design, and service properties differ too. For these reasons, only the engineering characteristics of clad steels are treated here. Applied liners will be discussed in a later article.

Clad Steels: Clad steels are most often available commercially in the form of plates. Various combinations obtainable have stainless types 304, 304L, 309, 310, 316, 321 and 347, nickel, Monel, Inconel or copper bonded to mild steel. Plates of aluminum and silver clad to steel have also been produced commercially. Special forms consisting of copper clad to stainless and many other combinations of the above materials are also produced. Thickness of the cladding generally amounts to about 10 to 20 per cent of the total sheet or plate thickness.

Of the many different possible procedures for the manufacture of clad steels, only a few are used commercially: (1) a stainless or nonferrous plate is fillet-welded to the backing steel, (2) the cladding metal is cast onto the backing steel, or (3) the cladding metal is applied by one of several welding methods. Thus joined initially, composite slabs are heated to forging temperatures which vary with the cladding material and subsequently reduced by hot rolling. On stainless steel, nickel, and nickel alloys both the cladding material and backing steel are uniformly reduced by hot rolling. Where softer cladding materials such as copper and aluminum are involved, the backing steel is reduced little, if any, and the rolling consists essentially of a continous tacking operation. On smaller sizes continuous bonding can also be accomplished by hot pressing.

Clad plates for large pressure vessels have been produced also by brazing. The "base" backing steel plate and cladding plate are cut to a size somewhat larger than the finished plate size required. A brazing alloy is applied prior to placing the cladding plate onto the backing steel. Bonding is accomplished by a heating and pressing operation on the two plates.

Clad piping is produced in two ways. One method is centrifugal casting, first the outer material and subsequently the inner material. The other is hot extruding a composite tubular assembly consisting of a tube of one composition slipped or pressed into a tube of another composition and of slightly larger diameter. Small-diameter clad piping is usually made by the latter process. The cladding can be either on the outside or on the inside. A cross-section of a pipe clad with Type 347 stainless is shown in *Fig.* 1. Outside diameter is 6½ in.; inside diameter is 3 in.

Cladding can also be applied by compressing a tube of larger diameter onto a backing tube of smaller diameter. A copper-clad steel product of this type is shown in *Fig.* 2 .

Welding: In service applications involving corrosive environments, a weld on the cladding side must have corrosion resistance equal to that of the cladding material. Also, the weld should have sufficient strength and ductility to meet anticipated service requirements.

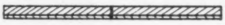
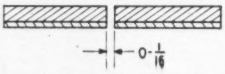
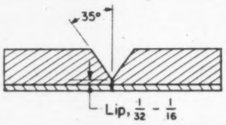
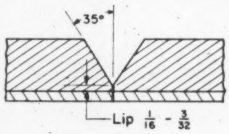
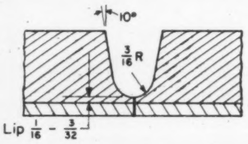
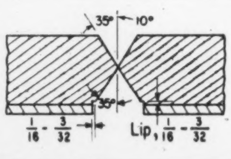
Joint designs and welding procedures depend, in part, upon the ability to weld from both sides or from one side only. Joints accessible from only one side are generally called *blind* joints.

Accessible Joints: Recommended joint designs and welding conditions for butt joints in plate accessible from both sides are shown in *Table* 1.

Wall thicknesses up to 1/16-in., although accessible from both sides, usually are welded in one pass from the cladding side.

On thicknesses from 1/16 to ⅛-in., two or more passes are preferred. They should both be deposited from the cladding side. A straight butt joint is preferred with the root toward the back-

Table 1—Recommended Designs and Procedures for Butt Joints in Clad Steels

Sheet or Plate Thickness (inches)	Joint Design (Dimensions in inches)	Welding Recommendations	
		Technique	Materials
Up to $\frac{1}{16}$		Make one pass on clad side.	Use electrodes or welding rods depositing weld metal of composition similar to cladding. Where weld metal dilution may be involved, the electrode or welding rod should be more highly alloyed than the cladding material.
$\frac{1}{16}$ to $\frac{1}{8}$		Make two passes, both on clad side.	Use electrodes or welding rods depositing weld metal of composition similar to cladding. Where weld-metal dilution may be involved, the electrode or welding rod should be more highly alloyed than the cladding material.
$\frac{1}{8}$ to $\frac{1}{4}$		Make two passes: first on backing side, second on clad side.	Use electrodes or welding rods depositing weld metal of composition similar to cladding. Chip or grind out clad side prior to welding, Fig. 3.
$\frac{1}{4}$ to $\frac{3}{4}$		Make two to four passes. Follow procedure in Fig. 3.	Weld backing-steel side with steel electrodes and cladding side with electrodes recommended in Table 2 .
Over $\frac{3}{4}$	 10° $\frac{3}{16}$R Lip $\frac{1}{16}$ - $\frac{3}{32}$	Make two to twelve passes. Follow procedure in Fig. 3.	Weld backing-steel side with steel electrodes and cladding side with the electrodes recommended in Table 2.
Over 1	 35° 10° 35° $\frac{1}{16}$ - $\frac{3}{32}$ Lip, $\frac{1}{16}$ - $\frac{3}{32}$	Make numerous passes.	Weld backing steel with steel electrodes from both sides of double-V groove. Then deposit cladding layers.

ing steel side and *through* welding from the clad side.

Over ⅛-in., the backing steel side should be welded first, then the cladding side, *Fig*. 3.

The electrode and welding rod compositions ordinarily recommended for welding the clad side are listed in *Table* 2.

In service applications where the surface of the weld deposit on the cladding side should exhibit essentially the same corrosion resistance or other properties as the cladding material, dilution of the surface layer of the weld metal generally should be kept to a minimum. Electrodes or welding-rods selected for the job should produce weld metal not adversely affected by dilution. On stainless-clad steels, recommended electrodes or welding rods are chromium-nickel alloys somewhat higher in alloy content than the cladding material. Where thickness of the cladding layer is less than ⅛-in., it is also advisable to minimize dilution by depositing the initial weld passes adjacent to the backing steel with small-diameter electrodes at low current. This minimizes heating and melting of the backing steel.

Blind Joints: On piping and other forms where the weld must be made from one side only, special joint designs are required. Where backing strips can be used, suitable joint designs are illustrated in *Fig*. 4. Welding is by the shielded metal-arc process with covered electrodes. Where a smooth surface contour on the blind side is desired, as in most piping systems, the joint should be prepared as shown in *Fig*. 5. The root is usually welded by the inert-gas tungsten-arc process. On heavy pipe sizes the balance of the weld is usually completed by shielded metal-arc welding. This practice is used in the piping industry even on solid homogeneous materials and particularly in power piping installations.

Where the steel side is blind, the electrode and welding rod compositions recommended in *Table* 2 should be followed.

Where the clad side is blind, the cladding should be welded with electrodes or welding rods of the same type of composition as the cladding metal, unless dilution must be considered. Special problems, however, may be involved in completing the weld.

On most materials of wall thicknesses up to ½-in., the best practice is to complete the whole weld with the same electrodes or welding rods as used to weld the cladding. This is not applicable to some nonferrous clad steels. On aluminum-clad steels, for example, the strength of the back-up steel must be maintained. On such materials, special types of joints with over-lap-type root preparations may be required.

On wall thicknesses over ½-in., it is frequently desirable to complete the weld with mild or low-alloy steel electrodes after the clad root of the joint has been welded with the proper high alloy steel or nonferrous electrodes. Care must be exercised in selecting the electrodes or welding rods and the welding procedure. They should not produce a brittle transition zone in the finished weld. It is frequently desirable to deposit a transition weld having properties somewhat between those of the cladding and backing steel. This is called *buttering*.

It is considered undesirable, for example, to deposit mild or low-alloy steel weld metal against the austenitic stainless steels. The transition zone

Table 2—Electrode and Welding-Rod Compositions for Welding Clad Steels

Cladding Metal	For First Layer on Backing Steel and for "Through" Welding*†	To Complete Weld*	Alloy to Steel* (welds not exposed to corrosion)
302	E310, E309	E310, E309, E308	E310, E309
304	E310, E309	E310, E309, E308	E310, E309
304L§	E310 Cb, E309 Cb	E310 Cb, E309 Cb, E347	E310, E309, E310 Cb
309	E310	E310	E310
310	E310	E310	E310
316	E310 Mo, E309 Mo	E310 Mo, E309 Mo, E316	E310, E309, E310 Mo, E309 Mo
316L§	E310 Mo, E318	E318	E310, E309, E310 Mo
321	E310 Cb, E309 Cb	E310 Cb, E309 Cb, E347	E310, E309, E310 Cb, E309 Cb
347	E310 Cb, E309 Cb	E310 Cb, E309 Cb, E347	E310, E309, E310 Cb, E309 Cb
405	E310, E309, E430‡	E310, E309, E430†	E310, E309
410	E310, E309, E430‡	E310, E309, E430†	E310, E309
430	E310, E309, E430‡	E310, E309, E430†	E310, E309
No. 20**	E310, E309	Stainless No. 20	E310, E309
Nickel	Nickel (No. 141)	Nickel (No. 141)	Nickel (No. 141); 80 Ni, 20 Cr (No. 142)
L-nickel	Nickel (No. 141)	Nickel (No. 141)	Nickel (No. 141); 80 Ni, 20 Cr (No. 142)
Monel	Monel (No. 140)	Monel (No. 140)	Nickel (No. 141); 80 Ni, 20 Cr (No. 142); Monel (No. 140)
Inconel	80 Cr, 20 Ni (No. 142)	80 Cr, 20 Ni (No. 142)	80 Cr, 20 Ni (No. 142)
Copper	CuSn-A	Copper	CuSn-A
Aluminum	Al (11-13 Si), Al	Aluminum	Al (11-13 Si), Al
Silver	Silver	Silver	Silver

*For stainless-steel electrode classification see "Selecting Electrodes and Welding Rods: Part 2—Stainless Steels." December, 1955.

†These specifications apply where weld-metal dilution is involved.

§The letter L, as adopted by the American Iron and Steel Institute, denotes the extra-low-carbon (0.3 max C) grades.

‡Must be used under certain corrosive conditions and may require special preheat and postheat-treatments.

**Base steel clad with Carpenter 20 stainless steel.

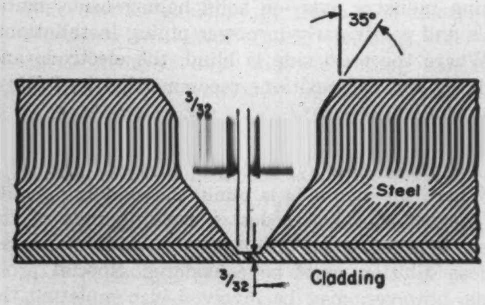


Fig. 5—Above—Recommended joint preparation for clad pipe joints requiring smooth internal contour

Fig. 6—Below—Cracking in a brittle transition weld after bending 5 degrees. A carbon steel weld metal layer had been deposited on stainless steel

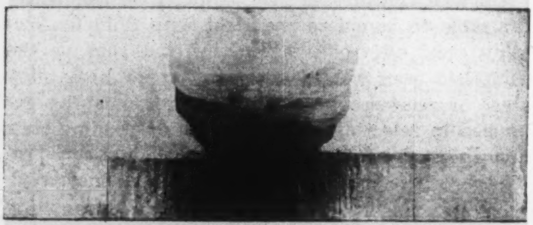
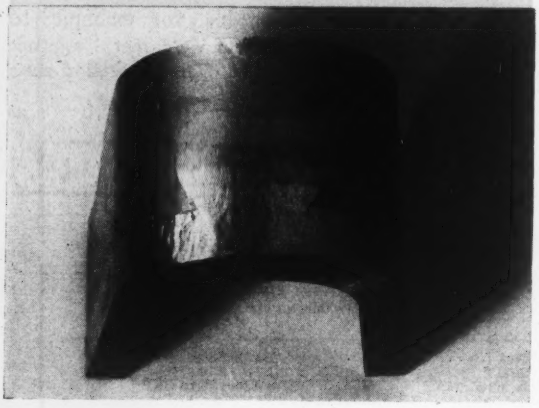


Fig. 7—Bend test of properly made Type 304 clad stainless steel pipe weld



would tend to be rather hard, brittle and highly susceptible to cracking, *Fig.* 6. The reverse is not true, however, as weld metal can be readily deposited against mild steel.

A weld made in a Type 304 stainless-clad pipe joint is illustrated in *Fig.* 7. The joint preparation is in accordance with *Fig.* 5. The root was welded by the inert-gas tungsten-arc process. This was followed by welding the balance of the clad layer by shielded metal-arc welding with E308 (18 Cr, 8 Ni) electrodes. The *buttered* layer adjacent to the backing steel was made by shielded metal-arc welding with electrodes which exhibit a metallurgical structure more like mild steel than the 18 Cr, 8 Ni alloy. The balance of the weld was completed with E6016 mild steel electrodes. Neither preheating nor postheating was necessary.

The welding procedure specified careful control over such variables as electrode size, current and stringer beading. These are representative critical factors in welding dissimilar-metal joints. The completed weld met the various tests required by inspection codes, as the bend test specimen in *Fig.* 7 indicates.

Welding Processes: Shielded metal-arc welding is most commonly used for welding clad steels with electrodes of mild steel, alloy steel, or nonferrous materials.

Inert-gas tungsten-arc welding produces very good results on light-gage clad materials, up to about 1/8-in., welded with the addition of the proper welding-rod materials. The inert-gas tungsten-arc process is also used in welding the root pass in clad piping, the balance of the weld being completed with shielded metal-arc welding.

Inert-gas metal-arc welding with consumable electrodes is occasionally employed on sections over 3/8-in. where the whole weld has to be made from the backing steel side. Control over dilution may be necessary by means of electrodes more highly alloyed than the base metal.

Submerged-arc welding is used in welding the steel side of plates over 3/4-in. thick or on heavy-wall clad piping with the backing steel on the inside (blind). Prior to submerged-arc welding, one or two *block* beads should be deposited by shielded metal-arc welding with mild steel electrodes to prevent burn-through with the submerged-arc process. On accessible joints the clad side should be welded by shielded metal-arc welding. On blind pipe joints where the cladding is on the inside, the root pass should be welded by inert-gas tungsten-arc welding. On relatively heavy clad sections several additional layers of the cladding alloy should be deposited by manual metal-arc welding.

Oxyacetylene welding is rarely used except on copper-clad steels where this process is suitable for welding the copper cladding.

Heat Treatment: The proper heat-treating temperatures and procedures must be based on the characteristics of both the backing steel and the cladding material. Care should be taken to specify a heat-treatment which produces beneficial effects in one material and yet will not harm the other. Cooling rates may have to be specified in cases where rapid cooling may affect adversely one of the materials. It must be recognized that the coefficients of the respective materials may differ considerably and may result in serious residual stresses.

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This article is the seventh in a co-ordinated group by Helmut Thielsch on welding and weldments. Previous articles, and the issues of MACHINE DESIGN in which they appeared, are:

Wrought Carbon and Alloy Steel: Weldability	May, 1955
Weldability of Stainless Steel	June, 1955
Weldability of Cast Steels	July, 1955
Selecting Electrodes and Welding Rods:	
Part 1—Mild and Low-Alloy Steels	Sept., 1955
Part 2—Stainless Steels	Dec., 1955
Designing Welded Joints For Dissimilar Steels	Apr. 5, 1956

Methods for SHEARING *high-speed* MOVING WEBS

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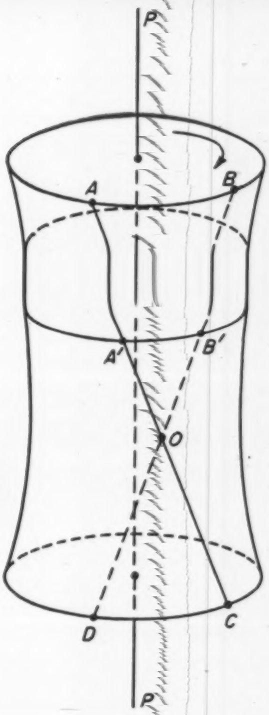

Fig. 1—Hyperboloid generated by straight lines *AC* or *BD* rotating around axis *PP*.

Several approaches have been employed in the design of machines for shearing continuously moving webs of material into sheets. Of course, each cutting technique has its own characteristic advantages and disadvantages. In the December, 1955, issue of *Machine Design* was an article by Erwin P. Pollitt entitled "High-Speed Web Cutting" which covered the advantages and limitations of four designs of shearing cutters—helical flycutters, hyperbolic flycutters, dual rotating shearing knives, and dual oscillating shearing knives.

This article discusses two additional cutting methods employing rotary hyperboloid knives and straight-edged helical knives. Both of these shearing techniques permit adjustment in cutting length and high-speed operation. Also, the cross-cutting knives in these two designs are relatively easy to make and sharpen.

PAPER-conversion machines, printing presses, packaging machines, or other machines working with a thin, flexible material like paper or aluminum foil often have to perform a so-called "cross-cutting operation." Through these machines passes a continuous web of material at constant velocity which must be cut into sheets of equal length. Usually such machines must meet the following design or operating requirements: (1) cutting length has to be adjustable, (2) the cut has to be a straight line and perpendicular to web edge, (3) the cutting point (contact between the two shear blades) should traverse web from one edge to the other in much the same way hand scissors work to achieve a smooth cut and to avoid impact shock between the blades, (4) grinding and sharpening of shear blades should be as easy as possible, a straight-line cutting edge being most desirable, and (5) the knife has to be capable of high speeds. Many methods have been devised and put into practice to achieve these desired results.

The generally known systems fall short in one or more of the design requirements just outlined. For example, the helical knife is not easily machined; the hyperbolic knife is not adjustable for different cutting lengths and it is difficult to grind correctly; oscillating knives are not suitable for high speeds.

This article discusses two other forms of cutters which have many advantages—the *rotary hyperboloid knife* and the *"straight-edged" helical knife.*

Rotary Hyperboloid Knife: Originally developed by Maschinenfabrik F. Lerner in Vienna, Austria, the rotary hyperboloid knife is employed to some extent in the United States and Canada. The

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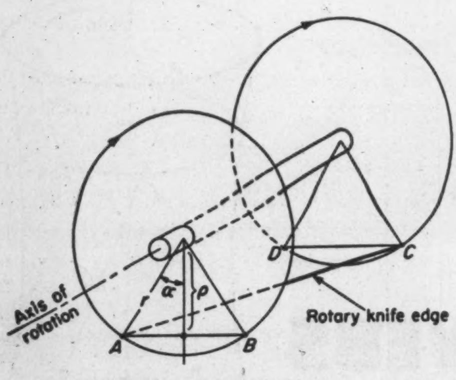
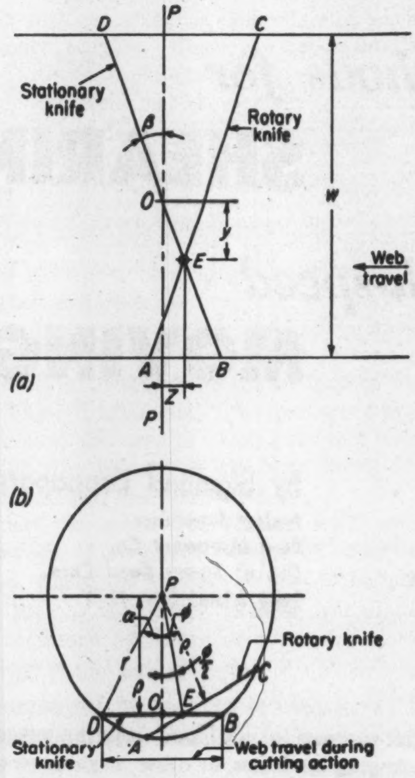


Fig. 2—Above—Schematic view of rotary hyperboloid knife arrangement with the rotary knife positioned at the midpoint of a cut.

Fig. 3—Right—Rotory knife in some arbitrary position during a cut is shown by top view, *a*, and end view, *b*.



geometrical principles of operation of the rotary hyperboloid knife will be presented in the following discussion.

Assume straight line *AC* in Fig. 1 is not parallel to nor does it intersect axis *PP*. If line *AC* is rotated around axis *PP*, it generates a hyperboloid. Exactly the same hyperboloid can be generated by another straight line *BD* which is located symmetrically to *AC*. If axis *PP* and line *BD* are both held fixed in space while line *AC* is rotated around *PP* as before, then all points on line *AC* will come successively in contact with all points on line *BD*. In other words, if *BD* represents the cutting edge of a straight stationary blade and *AC* represents the cutting edge of a straight rotating blade, a cut will be effected that has all the characteristics of a shearing action, since the point of contact between the two blades travels from one end of the blade to the other across the web. However, the web would not be cut in a geometrically exact straight line because all points on the cutting edge of the rotary knife are located at different distances from their common axis of rotation, and hence, they travel at different linear velocities.

In Fig. 2 is a perspective schematic view of the knife arrangement which will aid in an analysis of the actual cutting curve. The rotary knife in some arbitrary position during the cut is shown by a top view in Fig. 3*a* and by an end view in Fig. 3*b*.

Web velocity *c* is assumed to be constant. Angular velocity of the knife ω can be adjusted to a constant value for any given sheet length *l* permitting the knife to make one revolution in the time the web travels the given sheet length *l*.

In regard to the other notations marked in Figs. 2 and 3, *r* is chosen so that $2\pi r$ is not less than

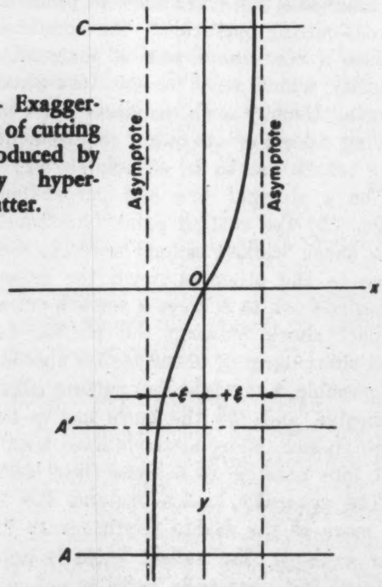
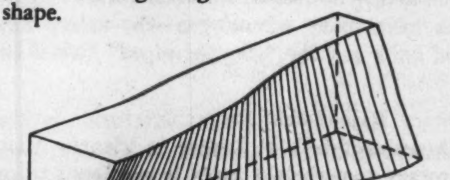


Fig. 4 — Exaggerated view of cutting curve produced by a rotary hyperboloid cutter.

Fig. 5—Exaggerated perspective view of a forming bar with a helical shape used to bend a straight-edged knife to a helical shape.



the shortest sheet length handled; this means the circumferential speed of the knife should not be less than the web speed, otherwise crowding of the web material behind the trailing edge of the rotary blade would occur during the cutting operation. Since the knife performs one revolution per cut, it has to rotate slower for long-cut sheets and faster for short ones, while web speed remains constant.

The choice of the skew angle α depends on w, the width of the web. The skew angle should be chosen so that the resulting offset angle β is 2 or 3 degrees, or from the expression $r \sin \alpha = w \times \tan \beta$, $\sin \alpha \approx 0.045\, w/r$. Under these geometrical conditions, the web moves through distance l in the time T or $T = l/c$. In this time the knife can make one revolution. During the cutting time t the knife rotates through 2α. Hence, $t/T = 2\alpha/2\pi$ or $t = T\alpha/\pi = l\alpha/c\pi$. In this time the web has traveled $tc = l\alpha/\pi$.

Assume for the time being that r in Fig. 2 is chosen so that $AB = l\alpha/\pi$. Consequently, $r = l\alpha/(2\pi \sin \alpha)$. The circumferential speed of the knife would, under these conditions, be somewhat greater than the web speed, and the rotational axis of the movable knife would lie perpendicular to the web travel. Incidentally, circumferential knife speed equals $c\alpha/\sin \alpha$.

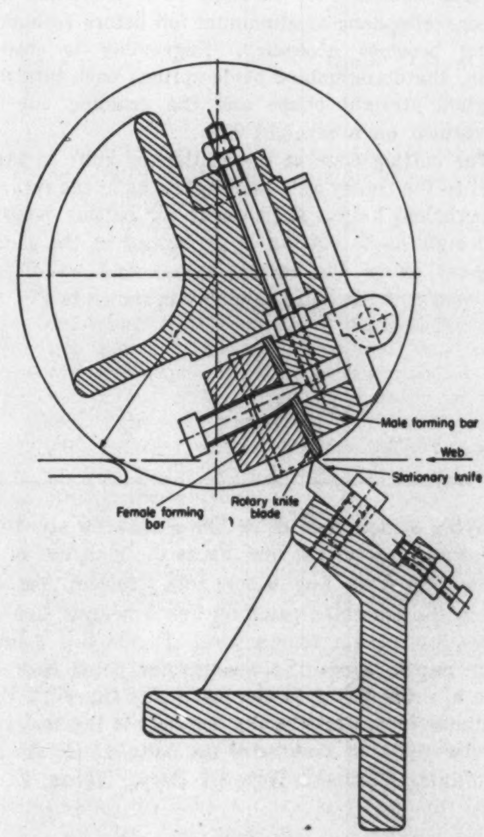


Fig. 6—Cross-section of a machine with a "straight-edged" helical rotary knife.

The cutting point is E, the point of contact between the rotary and the stationary knife blade in one particular instant corresponding to ϕ, the angular displacement of the rotary knife. Point E, which coincides at the start of cutting with point A on the rotary blade and with B on the stationary one, travels successively along the blades (and the web) and, at the end of the cut, coincides with C and D. The path that E describes relative to the moving web will also be the shape of the web cut. The question is, "What will this shape be?"

The contact point E travels in the time τ from E to O, Figs. 3a and b. Then distance $Z = \rho \tan (\phi/2)$. But since $\phi = \omega\tau$, $Z = \rho \tan (\omega\tau/2)$ and distance $y = Z/\tan \beta = \rho \tan (\omega\tau/2)/\tan \beta$. The web traveled in time τ distance x, and $x = c\tau$.

The equation of the cutting curve, shown in Fig. 4, is therefore, in parameter form,

$$x = c\tau$$

$$y = \frac{\rho \tan\left(\dfrac{\omega\tau}{2}\right)}{\tan \beta}$$

or, explicitly

$$y = \frac{\rho \tan\left(\dfrac{\omega x}{2c}\right)}{\tan \beta}$$

Since ρ, β, ω and c are constants, the preceding expression can be written:

$$y = m \tan (nx)$$

This curve is shown with an exaggerated x-scale

Nomenclature

c = Web velocity, in. per sec
l = Sheet length, in.
m = Constant
$= \rho/\tan \beta$
n = Constant
$= \omega/2c$
r = Distance from axis of rotation to cutting edge of hyperboloid knife, in.
T = Length of time required for web to move through sheet length l (also time required for rotary knife to complete one revolution), sec
t = Length of cutting time—period of time between engagement and disengagement of knife blades, sec
w = Web width, in.
α = Knife skew angle, deg
β = Web offset angle, deg
ϕ = Angular displacement of rotary knife, deg
ω = Angular velocity of rotary knife, rad per sec

in Fig. 4. The asymptotes of the curve are

$$\xi = \pm \frac{\pi \varrho \tan \alpha}{2 \alpha}$$

This cutting curve deviates little from an exact straight line because of the smallness of tan β. On a web 3 ft wide, the deviation proved to be of the order of 0.010-in.

It is advantageous to design the knife so the two ends of the rotary blade are not the same distance from the axis of rotation, such as A and C in Figs. 1 and 4, but are located at points A and A' respectively. Only the part of the curve close to the asymptote is used, which makes the deviation from an exact straight line even smaller.

The stationary blade and the rotation axis of the movable blade are held in a frame at a predetermined relative angular position to each other; this angle is obtained from the constant skew angle α. The angular position of this frame with respect to the web travel, however, is adjustable for different cutting lengths to make certain the cut is performed at right angles to the web edge. The rotary knife is driven through bevel gears to make this adjustment possible. Speed of the knife, which corresponds to the cutting length, is set by means of change gears.

If cutting lengths longer than those the knife was designed for are to be handled, then elliptical gears or some other variable-speed mechanism can be placed in the chain of change gears, so that the circumferential speed of the knife edge during the cut is slightly larger than the web speed. This method has been successfully applied.

"Straight-Edged" Helical Knife: Although the knife just described performs cuts which are, for all practical purposes, straight lines, it is sometimes desired, especially for large web widths, to use a knife with a theoretically exact straight cut. This requirement is met by the "straight-edged" helical knife.

If the cutting edge of the rotary knife is a helix wound upon a cylinder and the stationary knife has a straight-line cutting edge, a theoretically straight cut is performed because all points on the rotary knife are equally distant from their center of rotation. However, it is difficult to grind a helical cutting edge on a rotary knife. In order to overcome this difficulty, the author, then at Maschinenfabrik F. Lerner, Vienna, devised and put into operation the following simple method.

A flat, straight, comparatively thin knife blade is used that has a straight-line cutting edge. This blade is sandwiched between two appropriately milled "forming bars." The bars, pressed together by screws, force the knife blade to assume the correct shape, much in the same way as a razor blade is bent into the desired shape in a safety razor. An exaggerated perspective view of one of these bars is shown in Fig. 5; the other bar is the mate to this one. Obviously, these bars must be carefully milled to the helical shape to let them rotate, not around their geometrical center, but rather their operating center. A helix angle of 1 to 2 degrees is satisfactory.

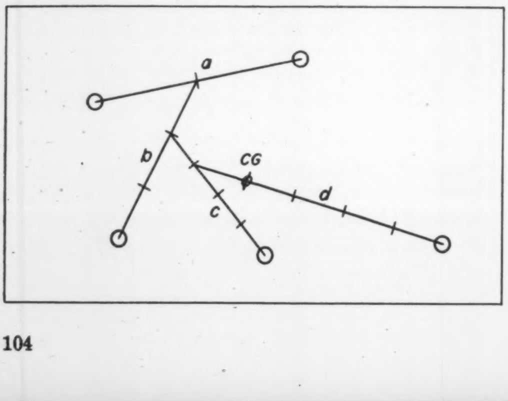
A rotary blade about 3/32-inch thick can stand several million cuts through such materials as paper, cellophane or aluminum foil before resharpening becomes necessary. Regrinding is easily done; the disassembled blade springs back into its original straight shape and the grinding cut is performed on a straight line.

The cutting edge of the stationary knife is parallel to the rotary axis—not askew as in the rotary hyperboloid knife. Adjustment for cutting length and right-angle cutting is performed in the same manner as in the rotary hyperboloid knife. A schematic of the knife assembly is shown in Fig. 6.

Tips and Techniques

Locating Center of Gravity

A SIMPLE graphical method may be employed to locate the center of gravity of an unsymmetrical hole or bolt pattern. Referring to the accompanying sketch, first draw line *a* between any two holes and bisect that line. From the midpoint of *a* draw line *b* to any other hole. Trisect line *b*. From the one-third point on line *b* nearest line *a*, draw line *c* to a fourth hole. Divide line *c* into four parts. From the one-quarter point nearest line *b*, draw line *d* to the last hole. One-fifth the distance from line *c* to the last hole is the location of the center of gravity of the pattern.—DAVID R. BIRCHALL, *Goodyear Aircraft Corp., Akron, O.*



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Practical selection data for

Sleeve Bearing Materials

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SELECTION of the correct material for a sleeve bearing can be approached in many different ways. Without doubt, the most reliable method would be to perform service tests with the bearing in the machine in which it is to operate. Unfortunately, required life of a bearing and other considerations may be such as to preclude such tests.

Although it is impossible to perform life tests

Table 1—Typical Bearing Material Uses

Solid babbitt bearings are still poured for some machinery. Bearings are occasionally bored from solid babbitt bars for low-cost light-load applications.

Cast bronze bearings are used for high loads at very low speeds.

Cast leaded bronze is used for heavy duty service at low speeds (roll neck bearings, cable drum bearings); heavy loads where relative motion is limited (piston pin bearings); light loads where demand for surface properties is not great (instruments, fractional-horsepower motors, light-duty machinery); corrosion resistance (pumps), and applications where a bronze casting can function both as a bearing and some other machine element.

Cast copper-lead is useful at higher speeds at lower loads than the leaded bronzes where better surface properties are desired (large electric motors and large internal combustion engines).

Cast aluminum is used for higher loads than cast copper-lead, heavy-wall diesel engine bearings for example.

Sintered bronze impregnated with oil serves well for light loads or where oiling is difficult or undesirable (instruments, home appliances, washing machines).

Sintered iron costs less and carries higher loads than sintered bronze.

Wrought bronze sheet is used for low-cost applications where bearings can be pressed into a hole (wrist pin, piston pin, knuckle pin).

Graphited wrought bronze is used in applications where lubrication is difficult (water pumps).

Graphited cast bronze is used where bearings run at high temperatures up to 400 F.

Solid graphite is used for furnace bearings at temperatures to 600 F.

Plastic bearings perform well in light load applications where oiling is objectionable (textile machinery, light-duty home appliances, toys).

Babbitt on bronze is used where heavy babbitt will carry the load and the shaft must be protected if the babbitt breaks away (railway journal bearings, connecting-rod and main bearings for large internal-combustion engines).

Babbitt on steel is generally used for pressed-in bearings with moderate loads (motors; turbines; generators; automotive main, connecting-rod and camshaft bearings; high-speed thrust surfaces).

Microbabbitt on steel will carry heavier loads than thick babbitt. Thickness of the babbitt layer is from 0.002 to 0.005-in.

Copper-lead on steel carries higher loads than babbitt on steel.

Aluminum on steel carries heavier loads than copper-lead on steel.

Overlay bearings use a plated layer of lead or tin alloy, 0.001-in. thick. This overlay increases the load capacity of copper-lead and improves the surface properties of aluminum.

Overlay silver on steel is used for high speed at high loads (internal-combustion aircraft engine bearings).

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whenever a bearing material must be selected for a particular application, a knowledge of the properties of various commonly used bearing materials

often constitutes an acceptable substitute. Since operating requirements of a new bearing are often comparable to or nearly identical with an existing, successful bearing, a first approach to material selection is to use the same material performing successfully in an existing application, *Table* 1. In the event that some particular factor in a new design varies sufficiently to call for use of a new material, knowledge of the comparative characteristics of bearing alloys will serve as a useful tool in material selection.

This article will detail certain of the known properties of existing bearing materials which may be applied in this fashion. Although absolute values cannot be given to many of the qualities of bearing materials to be discussed, the comparative values given are useful and reliable. For example, in a given application, it is certain that bronze will have higher load capacity and lower wear rate than will babbitt. It is likewise true that these desirable features are obtained at a price of increased shaft wear rate and reduced seating ability.

Speed and Load Ratings: In most cases, use of a bearing material is limited by load and speed. Assuming that the fit is satisfactory and lubrication adequate, an improper alloy will either lose size by pounding out or squashing, or it will overheat and seize or melt out. Size will be lost by movement of material due to overloading. Overheating is due to higher friction associated with the harder alloys. Comparative load and speed ratings for various bearing metals are given in *Table* 2.

Table 2—Comparative Load and Speed Ratings

Material	Comparative Speed Rating	Comparative Load Rating
Babbitt	1	6
Copper-lead	2	5
Aluminum	3	4
Leaded bronze	4	3
Silver	5	2
Bronze	6	1

Table 3—Load Capacities of Babbitts

SAE Designation	Relative Load Rating	Composition
No. 11	100	87 Sn, 7 Sb, 6 Cu
No. 13	75	5 Sn, 85 Pb, 10 Sb
No. 14	100	10 Sn, 75 Pb, 15 Sb
No. 15	125	1 Sn, 83 Pb, 15 Sb, 1 As

Table 4—Load Ratings of Copper Alloy Bearings

Material	Relative Load Rating	Composition
Bronze	200	90 Cu, 10 Sn
Leaded bronze	150	80 Cu, 10 Sn, 10 Pb
Leaded bronze	100	83 Cu, 7 Sn, 7 Pb, 3 Zn
Leaded bronze	75	80 Cu, 5 Sn, 15 Pb
Copper-lead	50	70 Cu, 30 Pb

Babbitt, lead or tin are required for low friction in high-speed applications. Such surfaces are also desirable for good seating, ability to embed dirt and ability to conform at low loads regardless of the speed. When load is the limiting factor, a stronger alloy lower in the table must be used, but in general the softest alloy that will properly sustain the required load should be used.

Since there are appreciable differences among babbitts further data on these alloys is given in *Table* 3. Tin babbitts, such as No. 11, are used for corrosion resistance. Lower cost lead babbitts are used when corrosion is not a factor. No. 14 is the most popular lead alloy, but 13 is used where a softer alloy is desired, whereas 15 is preferred for higher load or longer life.

Estimated relative load ratings of representative copper alloys are given in *Table* 4. Bronzes are high-load alloys restricted to low speeds or low relative movement under such loads. Leaded bronzes are general-purpose intermediate alloys used for a wide variety of applications under intermediate conditions. For higher speed applications the softer copper-leads are used.

In terms of hours of operation in automotive engines, the life of the bearings is relatively short. Load ratings for such service under pounding loads are given in *Table* 5.

Where bearings are expected to run for years rather than a few thousand hours, loads used as a basis for design are much lower. Typical load ca-

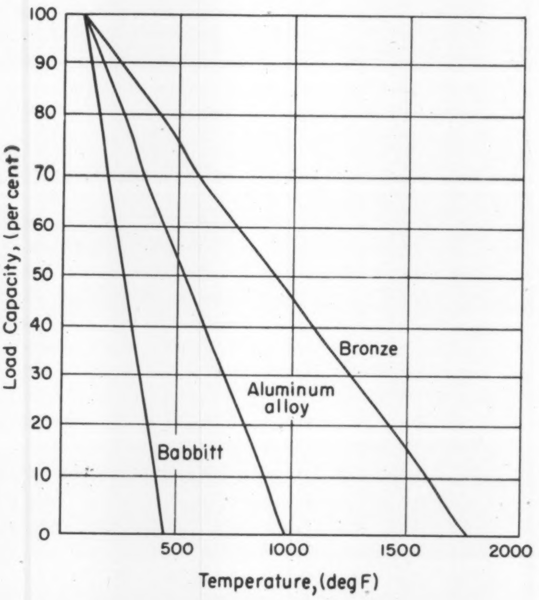


Fig. 1—Loss of load-carrying capacity of three bearing materials at elevated temperatures

Table 5—Load Capacities for Engine Bearings*

Material	Load Capacity (psi)
Aluminum	5000
Overlay on copper-lead	4000
Microbabbitt	3000
Copper-lead	3000
Babbitt	2000

*Steel-backed main and connecting-rod bearings.

Table 6—Load Capacities of Electric Motor Bearings

Material	Load Capacity (psi)
Bronze	200
Copper-lead on steel	150
Babbitt on steel	100
Babbitt on bronze	50
Sintered bronze	50

pacities for various bearing constructions used for long life in electric motors are given in *Table* 6. Replacement is dependent on the wear rate, even though the materials are commonly rated in terms of load capacity. Low loads are used to avoid overheating and the possibility of seizure.

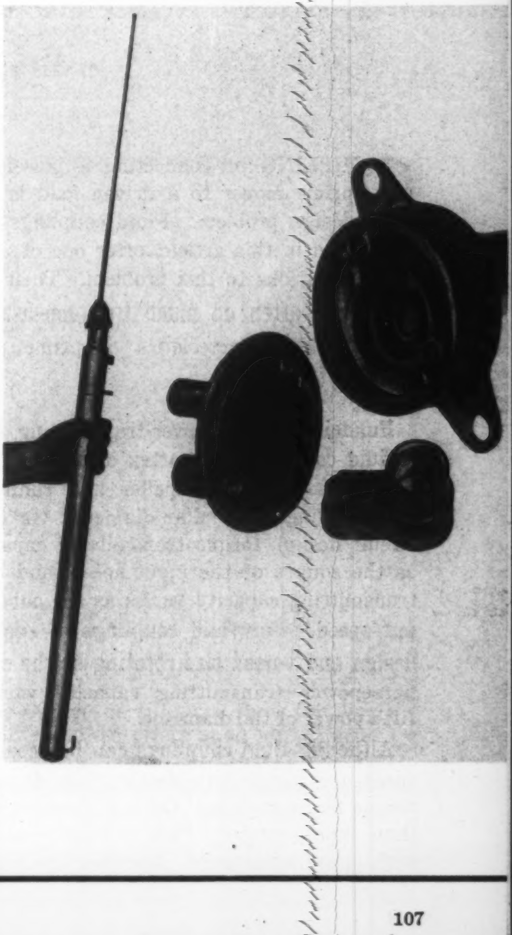
Temperature and Loads: Operating temperature of a bearing is the best single indication of the ability of the bearing to continue to run. Temperature measurements at the bearing back indicate that temperatures above 175 F are unsafe for electric motor operation. If a bearing is flooded with oil, by forced feed, temperatures of 200 to 250 F can be maintained if the oil is changed with sufficient frequency to avoid sludge formation. Low-melting alloys lose in load capacity as the temperature is increased. A rough estimate of the loss in physical properties accompanying increased operating temperatures is shown in *Fig.* 1.

Contemporary Design

Engine Vacuum Operates Auto Radio Antenna

ENGINE intake manifold vacuum is used to extend or retract a new automobile radio antenna. The antenna housing is a cylinder containing the piston on which the antenna proper rides. A diverting valve is used to connect intake manifold vacuum to either end of the cylinder and evacuate it, allowing air pressure to move the antenna in the desired direction. A push-pull knob on the automobile instrument panel controls the diverting valve. The antenna is a product of Pioneer Specialty Co.

The diverting valve is composed of three zinc die castings: a cover, slide and body. All required ports, projections and depressions are cored in the die castings. Only finishing operations required are lapping, tapping two cored screw sections, and drilling one hole.



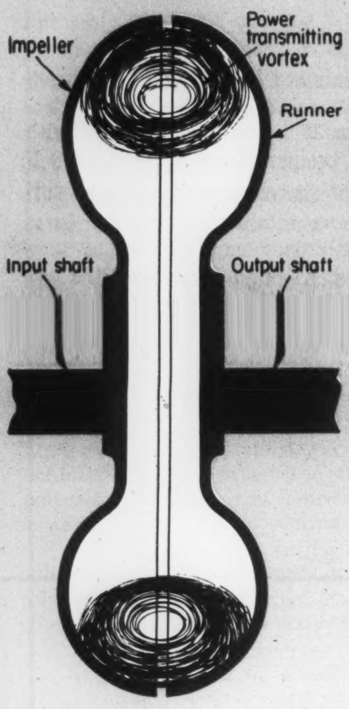


Fig. 1—Power transmitting medium in a fluid coupling is a vortex of fluid, most commonly oil. Kinetic energy imparted to the oil by the pump, or impeller, is transmitted to the turbine, or runner. Since energy transfer is the result of movement of the oil, fluid couplings are classified as hydrodynamic devices

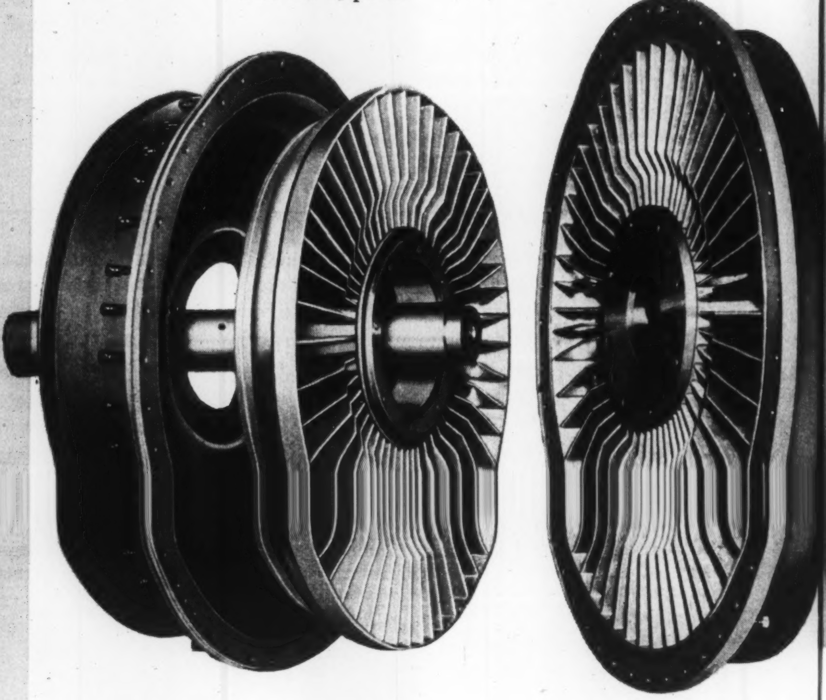


Fig. 2—Components of a traction fluid coupling are impeller, runner and casing. The casing is connected to and rotates with the impeller

Basic Facts about FLUID

By Ben Ragland, *Manager, Hydraulic Coupling Div.*
American Blower Corp., Detroit

COUPLING or connecting a power source or prime mover to a driven load is a common design problem. Fluid couplings, which are considered in this article, offer one of many alternative solutions to this problem. Their characteristics will often do much to compensate for the undesirable characteristics of prime mover and load.

Fundamentals: Power-transmitting medium in a fluid coupling is a vortex of oil which hydrodynamically connects impeller and runner, *Fig.* 1. For couplings of similar diameter, vortex size and circuit design, torque transmitting capacity varies as the square of the input speed, and horsepower transmitting capacity varies as the cube of the input speed. For fluid couplings of similar circuit design and vortex size rotating at the same speed, horsepower transmitting capacity varies as the fifth power of the diameter.

Although fluid couplings can be used to provide speed and torque adjustment, they do not produce torque multiplication. Output torque is never more than input torque. This characteristic, together with speed adjustment, describes the most obvious functional difference between a fluid coupling and a torque converter.

Stall torque of a fluid coupling is the maximum torque which the coupling will continue to transmit for a given fill or vortex size when used with a given motor. Stall torque is usually expressed as a percentage of the drivemotor rated torque. Graphically, it is the intersection of the coupling torque - speed curve and the torque - speed curve of the motor.

Fluid couplings can be classified according to type of fill, type of clutching action, or effect on output shaft rotation with constant input speed. Regardless of the method of classification used, fluid drives fall into two general categories, traction types and adjustable-speed types. These terms will be used to differentiate the two.

Traction Fluid Couplings

Traction-type fluid couplings consist basically of impeller, runner and an outer casing, *Fig.* 2. The input shaft connects to the impeller, the output shaft to the runner. The casing which surrounds

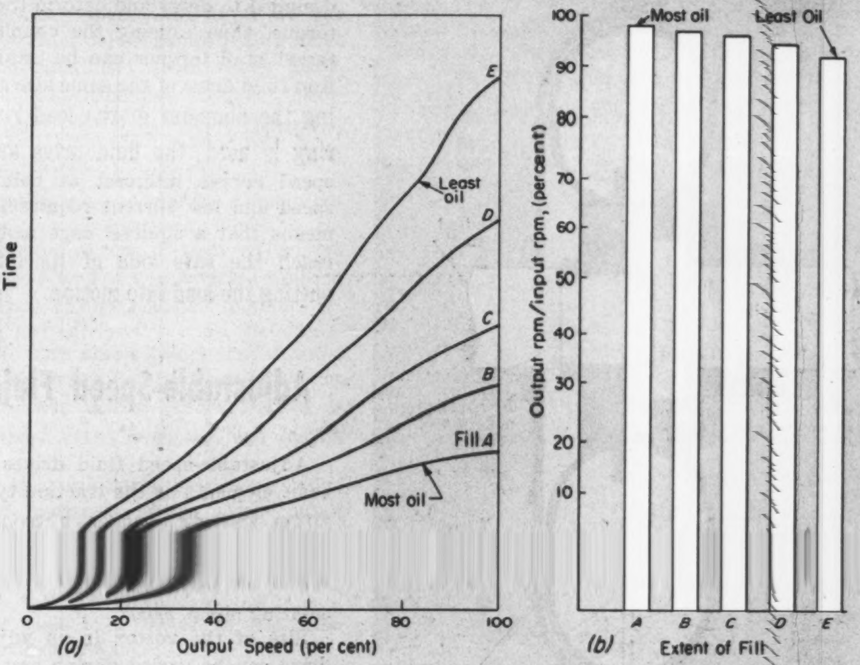


Fig. 3—Amount of oil in a traction coupling affects both acceleration characteristics, *a*, and the amount of slip, *b*. Input speed is constant in both instances

COUPLINGS

- Types
- Performance
- Selection
- Mounting
- Applications

the runner is connected to and rotates with the impeller, forming a sealed unit for retention of the hydraulic fluid. Cooling is by external radiation only; no supplementary cooling equipment is normally used, except on large capacity units.

In a traction fluid coupling, the vortex which transmits power from the impeller to the runner is nonadjustable during operation. Relation of input speed to output speed and acceleration characteristics are, therefore, also nonadjustable during operation.

Traction couplings are commonly used with general purpose ac motors in constant-speed applications. They are most generally used to protect drive motors and driven machinery from the adverse effects of possible shock loads, torsional vibration and excessive torque. They also simplify starting of high inertia loads when used with general purpose ac motors.

One very important function of a traction fluid coupling is its ability to limit the amount of torque being transmitted. The degree of this limitation is determined by initial filling and the internal design of the coupling itself. This ability to limit torque from the driving motor to the driven ma-

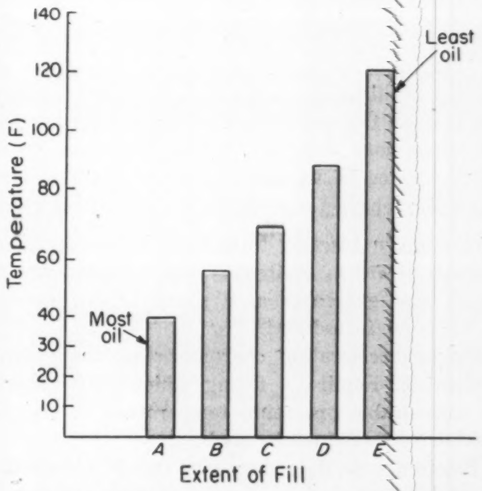


Fig. 4—Degree of fill of a fluid coupling also has a marked effect upon oil temperature at constant input speed. If fill is to be less than optimum in order to control speed ratio or acceleration characteristics, heat exchangers will be necessary in many instances

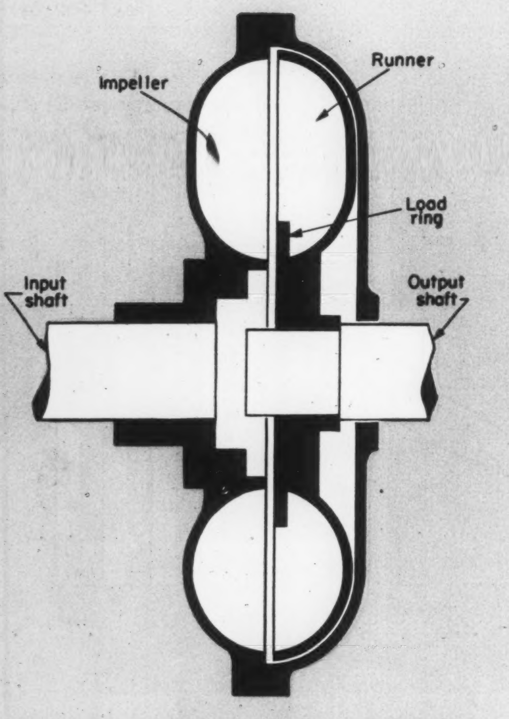


Fig. 5—A load ring will delay and deform the vortex in a fluid coupling at a given torque and cause the coupling to stall

chine gives the traction drive the properties of a shear pin. The coupling can perform the shear pin function repeatedly without the need of replacement or adjustment.

Although the traction fluid coupling is not generally considered as a device for controlling speed or acceleration, it can be used effectively for both in installations where these requirements are fairly constant and can be handled within the definite limits of the traction unit. Ratio of input speed to output speed for a traction drive can be altered by varying circuit design or by changing the amount of oil in the circuit which, in turn, changes the size of the power transmitting vortex. This cannot be done, however, during operation, *Fig.* 3.

The degree of variation in speed ratio and acceleration characteristics which can be achieved with a given traction fluid drive by reducing the amount of fill is limited by the amount of additional heat generated as a result of the increase in slippage introduced, *Fig.* 4. Where specified speed or acceleration characteristics for a given application require a filling which may produce an undesirable operating temperature, a traction fluid drive should not be used.

Traction type fluid couplings can be obtained in standard designs for use with motors rated from ½-hp to 200 hp. Special designs have been developed for applications involving ratings as high as 350 hp.

Stall torque at optimum filling is designed into a traction unit. One device used to control stall torque is the load ring, *Fig.* 5, or baffle mounted at the inner diameter of the runner. This ring is designed to delay and deform the vortex at a given torque, thus causing the coupling to stall. Different stall torques can be established for a traction fluid drive of the same size and design by varying the diameter of the load ring. Where a load ring is used, the fluid drive and motor torque—speed curves intersect at points of high motor speed and low current requirements, *Fig.* 6. This means that a squirrel cage motor is permitted to reach the safe side of its torque curve before putting the load into motion.

Adjustable-Speed Fluid Couplings

Adjustable-speed fluid drives contain the same basic elements as the traction type but have in addition an extra casing, a scoop tube and a circulating pump, *Fig.* 7.

Size of the vortex in an adjustable-speed fluid drive can be varied during any cycle of its operation, from no-load to full-load speed on the output shaft, to vary the output to input speed ratio and control the acceleration characteristics of the coupling. During periods of high-slip operation, when the vortex is small, excessive heating would result were the adjustable-speed fluid drive to rely on external radiation to cool the oil as is required with the traction type. Proper oil temperature is maintained by use of a supplementary oil cooler through which the oil is constantly circulated during coupling operation. Air type or water type oil coolers can be used.

Adjustable-speed fluid drives permit the use of

Many power-transmission devices for adjusting speed when a relatively fixed-speed prime mover is used are available to the designer. Articles dealing with electrical, mechanical and hydrostatic devices have appeared in recent issues of MACHINE DESIGN. Another of the various devices available—the *hydrodynamic* adjustable-speed transmission or adjustable-speed fluid coupling—is discussed in this article along with fixed-speed couplings. Kinetic energy of oil in motion serves as the power-transmitting medium in these fluid couplings rather than the energy of fluid under pressure as in the *hydrostatic* transmission.

general purpose ac motors in applications requiring variations in operating speed and duplicate the function of traction fluid drives in protecting drive motors and driven machinery from shock loads, torsional vibration and excessive torque. Additionally, as a result of their adjustable-speed characteristics, they offer:

1. Adjustable, stepless speed control for a wide variety of speeds and horsepowers. Where a reversible, single-speed electric drive motor is used, the fluid drive and load can be reversed while in motion by merely changing motor rotation.
2. Motor starting and acceleration under virtual no-load conditions. This allows design simplification in selection of motors and starting equipment for heavy starting loads. Across-the-line starting is practical in many cases, even on high inertia loads.
3. Automatic acceleration control through regulation of the rate of movement of the speed control lever or scoop tube positioning rod.
4. Declutching of load from motor at any time during any cycle operation.

Adjustable-speed fluid drives can be obtained in standard designs with ratings of 1 to 5000 hp. Special designs have been built for use with motors rated as high as 12,000 hp. Direction of input rotation may be either clockwise or counterclockwise in certain sizes. Dual rotation is available in sizes to 800 hp.

Vortex size and, consequently, stall torque can be varied in an adjustable-speed fluid drive during operation. Thus, this type of coupling can be controlled to meet any specific load requirement with-

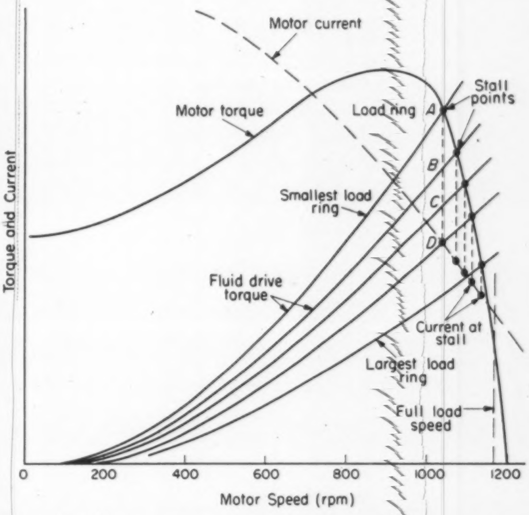


Fig. 6—How various load ring sizes may be used to regulate stall torque of a traction fluid coupling. Intersection of the torque curves of the motor and fluid coupling is the stall point. Projection of the stall point downward to the motor-current curve gives motor current at stall point

Typical Fluid Coupling Applications

Application	Fluid Coupling Used	
	Traction	Adj. Speed
Aircraft Industry Equipment		
Carburetor Blowers		x
Engine Testing		x
Hanger Door Drives	x	
Parachute Test Power	x	
Wind Tunnel Fans		x
Chemical Process Machinery		
Agitators	x	x
Centrifugal Pumps		x
Compressors	x	x
Crushers	x	
Extruders	x	x
High Pressure Reciprocating pumps		x
Homogenizers		x
Rotary Driers	x	
Conveyors		
Apron	x	x
Bucket	x	x
Chain	x	x
Overhead	x	x
Rotary Mold	x	x
Screw	x	x
Cranes		
Overhead Travelling	x	x
Fans and Blowers		
Fan Drive (General)		x
Fresh Air Supply		x
Fume Exhaust		x
Material Handling		x
Pressure Blowers		x
Glass Products		
Forming Material Fan		x
Gravel Pumps		x
Tank Cooling Fans		x
Ventilating Fans		x
Waste Liquor Pumps		x
Industrial Refrigeration Equipment		
Compressor		x
Laboratory and Shop Test Stands		x
Logging and Lumber Mill Machinery		
Peelers		x
Saws	x	x
Winches	x	x
Metal Working Machinery		
Coilers		x
Drawbenches	x	x
Forging Presses	x	
Square Shears	x	
Mining and Smelting Equipment		
Ball Mills	x	x
Centrifugal Pump		x
Crusher (Rotary)		x
Crushers	x	
Mine Hoists	x	x
Rotary Kilns		x
Scraper Hoists	x	x
Oil Field and Refinery Equipment		
Agitators	x	x
Compressors		x
Fan Drive		x
Fin Fan Cooling Unit		x
Generator		x
Oil Drill Rigs	x	x
Vane Type Rotary Pump		x
Paper Mill Machinery		
Black Liquor Pump		x
Calender (Friction)		x
Centrifugal Pump		x
Coaters		x
Cutters		x
Slitters		x
Stock Pump		x
Waxers		x
Plastics Machinery		
Extruders		x
High Pressure Reciprocating Pumps		x
Power Plant Equipment		
Boiler Feed Pumps		x
Centrifugal Pumps		x
Condensate Pumps		x
Forced Draft Fans		x
Induced Draft Fans		x
Mill Supply Fans		x
Rotary Driers		x
Process Machinery		
Centrifugals	x	
Grain Grinders	x	
Mixers	x	x
Steel Wool Machines	x	
Steeping Presses	x	
Pumps and Compressors		
Boiler Feed		x
Refrigeration		x
Sand Pumps		x
Slurry Pumps		x
Turbo-blowers		x
Water Supply		x
Rubber Making Machinery		
Extruders	x	x
Grinders	x	
Mold Conveyors	x	x
Winders	x	x
Steel Mill Equipment		
Coilers	x	
Cranes	x	
Furnace Chargers	x	
Rolling Mills	x	x
Slitters	x	x
Tumbling Barrels	x	
Textile Machinery		
Calenders		x
Extractors		x
Spinning Frames		x
Winders		x
Winches and Hoists		
Barge Pullers	x	
Car Pullers	x	
Mine Hoists	x	x
Trawler Winches	x	x
Wire Rope and Cable Machinery		
Cablers	x	
Rope Machinery	x	
Rubber Forcing	x	
Stranders	x	
Wire Drawing	x	

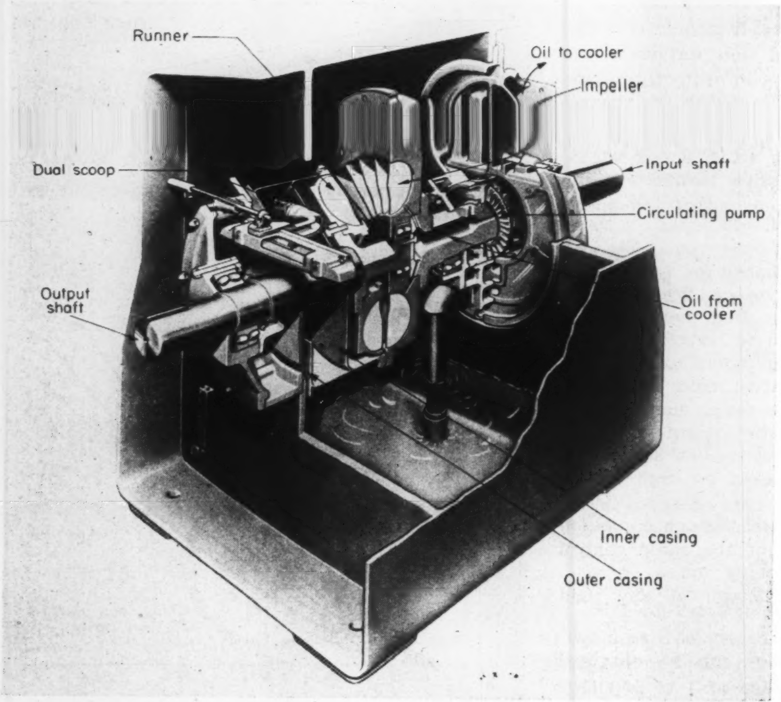

Runner
Oil to cooler
Impeller
Input shaft
Dual scoop
Circulating pump
Output shaft
Oil from cooler
Inner casing
Outer casing

Fig. 7—Output speed of an adjustable-speed fluid coupling is adjusted by regulating the amount of oil in the vortex with a scoop tube. In the fluid coupling shown, the scoop-tube adjusting mechanism is a sliding type actuated by a push-pull control rod. The circulating pump is used to supply a constant volume of oil to the fluid coupling

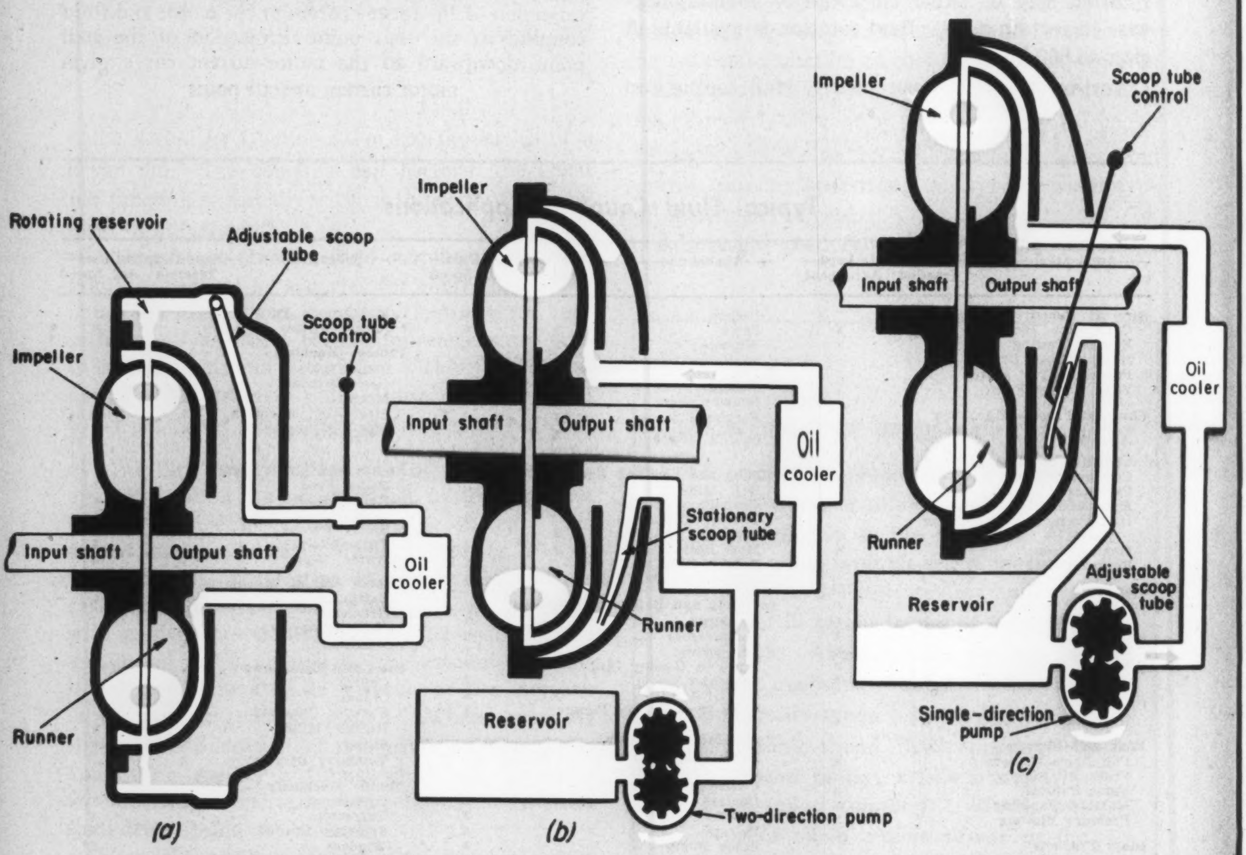

Rotating reservoir
Adjustable scoop tube
Scoop tube control
Impeller
Input shaft
Output shaft
Oil cooler
Runner
(a)
Impeller
Input shaft
Output shaft
Oil cooler
Stationary scoop tube
Runner
Reservoir
Two-direction pump
(b)
Impeller
Scoop tube control
Input shaft
Output shaft
Oil cooler
Runner
Adjustable scoop tube
Reservoir
Single-direction pump
(c)

Fig. 8—Three basic vortex control arrangements are commonly used with adjustable-speed fluid couplings. A rotating reservoir may serve to circulate the oil with vortex size determined by position of an adjustable scoop tube, *a;* a two-direction pump may be used to control the total amount of oil in the coupling, *b,* or a circulating pump may be used with vortex size controlled by an adjustable scoop tube, *c*

in its range. In the adjustable-speed fluid drive, vortex control is used to obtain the variation in output characteristics necessary to satisfy load requirements.

Vortex control is achieved with a scoop tube which removes oil from the vortex area. Three basic arrangements, *Fig.* 8, are commonly used: (1) rotating reservoir and adjustable scoop tube; (2) fixed reservoir, fixed scoop tube and two-direction pump; and (3) fixed reservoir, adjustable scoop tube and single-direction pump. The latter arrangement is most widely used. Where an adjustable scoop tube is used, it may be positioned by either a rotating or a sliding mechanism.

In the first arrangement, the reservoir itself acts as a pump causing flow through the scoop tube. The nearer the scoop tube opening is placed to the major diameter of the reservoir, the larger the vortex becomes. A continuous flow is maintained by constantly bleeding, through metering holes in the inner casing, a measured quantity of oil which passes into the rotating reservoir, through the scoop tube into the external oil cooler, and back into the working circuit. This serves to control oil temperature in addition to providing a "live" control of vortex size.

In the second arrangement the stationary scoop tube is positioned for maximum vortex. With this design, the two-direction pump determines the size of the working vortex. The scoop tube is merely the inlet through which oil is withdrawn from the housing by the pump. Fluid is constantly circulated through the external circuit of which

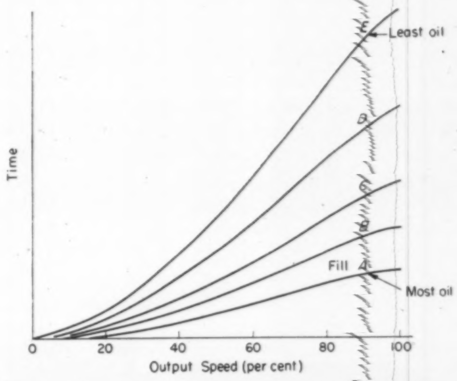


Fig. 9—Performance curves for a typical adjustable-speed fluid coupling show how variations in fill affect acceleration characteristics. Input speed is constant

Table 1—Traction Fluid Coupling Selection Data

Coupling Size			Power Rating (hp) At Various Speeds (rpm)										
OD (in.)	Length (in.)	Weight (lb)	1750	1620*	1450	1170	1080*	970	870	810*	720	690	585
13⅛	9	67	**20 to 30**	**15 to 25**	**15 to 20**	**7½ to 10**	**5 to 7½**	**5**	**3**	**2 to 3**			
14⅝	9	83	40 to 50	30 to 40	**25 to 30**	**15**	**10 to 15**	**7½ to 10**	**5 to 7½**	**5**			
16⅜	9⅞	102	60 to 75	50 to 60	40 to 50	**20 to 30**	**20 to 25**	**15**	**10**	**7½ to 10**			
17⅞	$10\frac{13}{16}$	125	100		60 to 75	**40 to 50**	**30 to 40**	**20 to 25**	**15 to 20**	**15**			
19½	$10\frac{13}{16}$	150	150		100	**60 to 75**	**50 to 60**	**30 to 40**	**25 to 30**	**20 to 25**			
$21\frac{3}{16}$	$12\frac{7}{16}$	180			150	100	75	**50 to 60**	**40 to 50**	**30 to 40**			
$22\frac{11}{16}$	$12\frac{11}{16}$	210				125 to 150		**75**	**60**	**50 to 60**	**30 to 40**	**30**	
25⅞	$15\frac{5}{16}$	290				200		**100 to 150**	**75 to 125**	**75**	**50 to 75**	**40 to 60**	
28⅝	18¾	420						200	**150 to 200**		**100 to 125**	**75 to 125**	**60 to 75**

*Full load speed of high-slip motor.

Horsepower ratings in light face type are such that oil temperatures may exceed prescribed limits when load and duty cycles are adverse.

Table 2—Adjustable-Speed Fluid Coupling Selection Data

		Coupling and Housing Size						
Power (hp)	Speed (rpm)	Length (in.)	Width (in.)	Height (in.)	Weight (lb)	Slip (%)	Oil Flow (gpm)	Control Force (lb)
800	1800	50½	45	49	4650	2½	39	110
800	1200	53	45	49	5825	3¾	34	90
800	1200	57½	50	54	7400	1¾	51	105
800	900	64	57	62	9300	2	80	95
800	720	74¾	66	71	11460	1¾	125	90
800	600	74¾	66	71	11460	3	125	80
900	1800	50½	45	49	4650	2¾	39	110
900	1200	57½	50	54	7400	2	51	105
900	900	64	57	62	9300	2¼	80	95
900	720	74¾	66	71	11460	2	125	90
900	600	74¾	66	71	11460	3½	125	80
1100	1200	57½	50	54	7400	2¼	51	105
1000	900	64	57	62	9300	2½	80	95
1000	720	74¾	66	71	11460	2¼	125	90
1000	600	74¾	66	71	11460	2¾	125	80
1000	600	82	76	83	14900	2	195	85

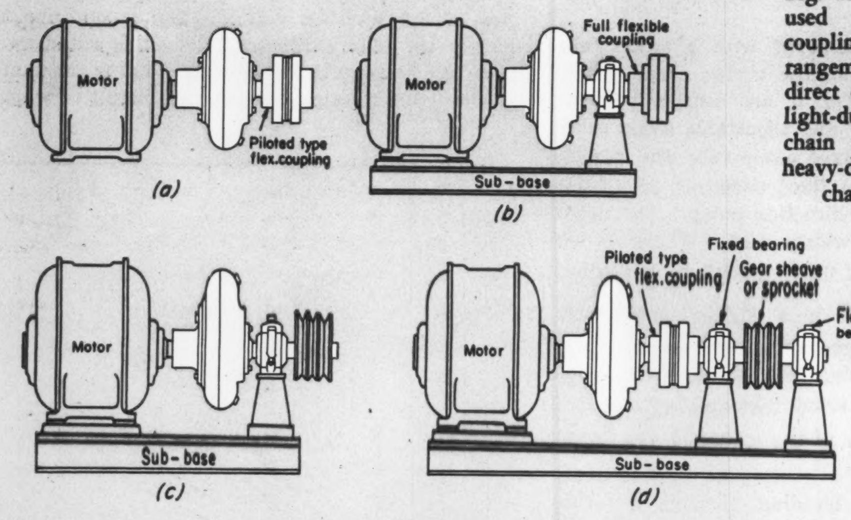


Fig. 10 — Commonly used traction fluid coupling mounting arrangements are for direct drive, *a* and *b*, light-duty belt or chain drive, *c*, and heavy-duty belt or chain drive, *d*

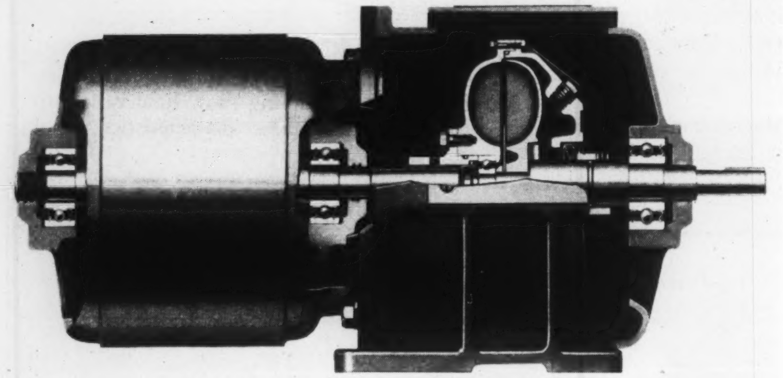


Fig. 11 — Packaged traction coupling units, in which the driving motor mounts on the coupling housing, are very compact. Units of this type are available with maximum output of 20 hp

the external oil cooler is a part.

In the third system, a constant volume of oil is pumped through the external oil cooler into the working circuit by a single-direction pump. At the same time, oil is metered back to the tank by the scoop tube. The position of the scoop tube in this arrangement has the reverse effect of that of the first system. The nearer the scoop tube tip is positioned to the major housing diameter, the smaller the vortex becomes.

Fluid Coupling Performance

Fluid coupling performance is determined by the hydraulic circuit design which establishes the manner in which flow control is achieved within the coupling. Circuit design includes the type and size of stall torque control element selected. The design of the circuit and the degree to which the coupling is filled are the two factors which establish speed, acceleration and stall characteristics.

An important factor in some installations is the time required to bring a load up to speed without overloading the drive motor. For a fluid drive of a given diameter and fill, acceleration time will vary with the flywheel effect of the load and the minimum slip of the coupling.

Effect of Slip: Slip is a measure of fluid coupling efficiency while operating under load. It is the difference in speed between coupling input and output, and is expressed as a percentage. If slip is 5 per cent, for example, the output shaft is rotating at 95 per cent of input shaft speed.

Minimum slip in a given fluid drive is governed by the amount of filling, the design of the hydraulic circuit and the maximum horsepower and speed required by the load. Minimum slip is a function of circuit size for a given load and speed.

A fluid drive with too little minimum slip generally results in a "hard" coupling action. When slip is increased "softer" coupling action results. Optimum minimum slip for a coupling of a given size and circuit design is generally determined by the normal duty requirements of the drive motor with which the coupling is to be used.

Because slip is required to transmit power with a fluid drive, the impeller will rotate faster than the runner even at optimum filling and maximum output speed. As *Table* 2 shows, minimum slip varies with horsepower and speed. Where minimum slip is 3 per cent, for example, output speed is 97 per cent of input speed.

Minimum slip for a particular application takes effect only when the unit is operating under full vortex conditions. For all other intermediate fill conditions, slip will be greater than minimum for the same load. This will affect acceleration characteristics as shown in *Fig.* 9.

Fluid Coupling Selection

Selection of the correct fluid drive size for a given application is a relatively simple matter. *Tables* 2 and 3 show portions of the type of selection data generally available from fluid drive manufacturers. Selection from these tables requires only horsepower and speed ratings of the motor with which the fluid drive is to be used.

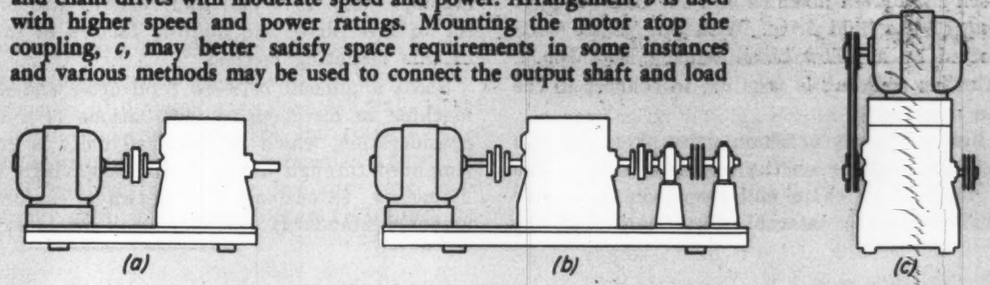
Where an adjustable-speed fluid drive is to be used, the type of control used to adjust the fill is not a factor in selection of the fluid drive itself, but is an important consideration in the performance and design of the overall machine drive. The method chosen will be determined by such factors as economic limitations, desired speed of response, duty cycle and availability of actuating media such as compressed air, hydraulic fluid or electricity.

Adjustable-speed fluid drives are available with either lever or handwheel control for scoop tube positioning. The handwheel permits fine adjustment with manual control but is not used where

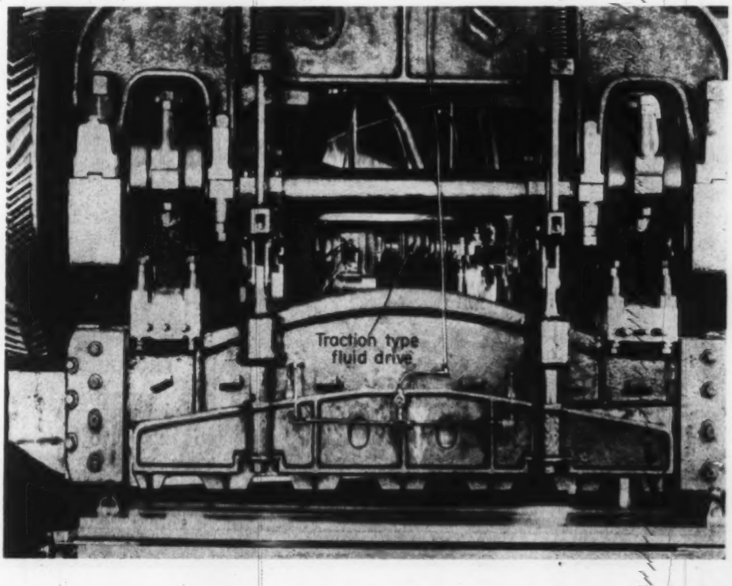
Table 3—Maximum Ratings for Overhung Belt Loads

Speed, max (rpm)	Power, max (hp)	Number and Size of Belts	Belt Pull (lb)
1200	10	4—B	290
1200	15	6—B	435
900	20	4—C	485
1200	30	5—C	525
900	30	6—C	725
900	50	5—D	840
720	50	6—D	1000
900	60	5—D	1000

Fig. 12—Some mounting and coupling arrangements commonly used with adjustable-speed fluid couplings. Arrangement *a* is for use with belt and chain drives with moderate speed and power. Arrangement *b* is used with higher speed and power ratings. Mounting the motor atop the coupling, *c*, may better satisfy space requirements in some instances and various methods may be used to connect the output shaft and load



A hub-mounted traction fluid coupling is used in this shear drive to prevent motor overloads during starting and provide closer control during jogging or inching. The fluid coupling also absorbs sudden overloads and prevents motor stall during the shock cycle of shear operation.



automatic control is required. The lever control is readily adapted to almost any type of automatic control device. Among the data normally provided by adjustable-speed fluid drive manufacturers is the force required to move the speed control rod, *Table* 2. This information, too, will be a factor in determining the control size to be used.

Mounting Arrangements

Traction Fluid Couplings: Several mounting arrangements are commonly used with traction type fluid drives, *Fig.* 10. Hub mounting of a traction unit directly on the shaft of an electric motor, *Fig.* 10*a,* possesses the inherent advantages of minimum space requirements and ease of assembly. Even greater compactness on a given foundation or base is possible with a so called packaged unit, *Fig.* 11. Packaged traction fluid drives are available in sizes up to 20 hp rated capacity.

Direct drive from the fluid drive to the driven machine is provided by certain mounting arrangements, *Figs.* 10*a* and *b.* With close coupled arrangement, *Fig.* 10*a,* a piloted type flexible coupling connects the output shaft to the driven machine. The output shaft is thus supported as a floating shaft between the driven machine and the internal pilot bearing of the fluid drive. With the output shaft supported by a pillow block bearing, *Fig.* 10*b,* a full flexible coupling is required to connect to the driven machine.

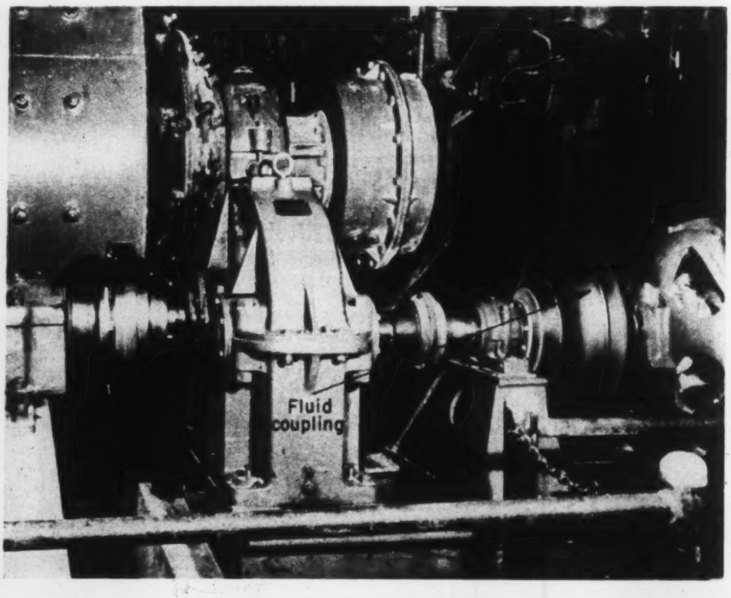
A light-duty belt or chain drive, *Fig.* 10*c,* has the pulley overhung on the runner shaft. In this case, the belt or chain pull reacts on the motor shaft through the internal pilot bearing of the fluid drive. Therefore, it is desirable to have the pulley overhang as short as possible. Maximum belt or chain pull permissible with this mounting is a function of not only the power rating of the fluid drive but of the speed of rotation and number and size of belts as well, *Table* 3.

Heavy-duty belt or chain drives, *Fig.* 10*d,* use two outboard bearings supporting a pulley shaft. This arrangement avoids belt reaction on the motor shaft and is recommended for all heavy-duty drives.

Adjustable-Speed Fluid Couplings: Standard mounting arrangements, *Fig.* 12, are generally used for adjustable-speed fluid drives. Direct connection to the motor, *Fig.* 12*a,* through a flexible coupling permits direct drive from the fluid drive output shaft through another full flexible coupling. This arrangement is most widely used because of its simplicity and minimum space requirement. It can also be used with sheave or sprocket for belt or chain drives involving moderate speeds and powers.

For belt or chain drive applications involving higher speeds and greater powers, two pillow blocks are used to support the output jackshaft, *Fig.* 12*b.* Another method, *Fig.* 12*c,* has the motor separately mounted, driving the fluid drive by means of belts. From the output shaft, direct drive through a full flexible coupling or belt or chain drive from a sheave or sprocket can be accomplished. Belt pull and relative size of motor to fluid drive are limiting factors in the use of this mounting method.

Shaft alignment between fluid drive and driven machine in direct drive installations is a major consideration, which in packaged units is greatly simplified through use of flexible couplings. Shaft diameters, extensions and keyways conform to accepted standards for industrial machinery.



In a ball mill drive, a traction fluid coupling reduces the peak current demand of the 150-hp drive motor by more than 1000 amperes during starting.

Curves simplify

Involute Gear-Tooth Layout

for strength calculations

By Harold M. Durham
Pittsburgh

TO EXPLOIT full use of involute gear teeth, special tooth proportions may be required at times. Since strength factors are not available, enlarged layouts of the teeth are generally necessary for analysis of strength.

One common method of making an involute layout consists of drawing successive tangents to the base circle and connecting the end points. Other methods involve the use of templates. A mathematical method for finding involute gear tooth constants uses polar co-ordinates (MACHINE DESIGN, Sept. 1955, Page 211).

Presented here is a simplified method of making an enlarged involute layout using a set of predrawn curves, *Fig.* 1. These curves have been drawn for a group of representative base circle radii. Graphic conversion of the profile from these "standard" radii to the actual base radius desired is a simple matter.

After drawing the given gear constants on a sheet of tracing paper, the designer may, by proper manipulation of the involute curves, trace the tooth outline. Actual use of the system can best be demonstrated by an example.

Assume a special long addendum pinion of the dimensions $D_p = 5$ in., $P = 4$, $N = 20$, $\alpha = 1.2/P = 0.3$, $b = 0.7/P = 0.175$, pressure angle $\phi = 20$ deg, $W = 1000$ lb. The base circle diameter $= D_p \cos \phi = 5(0.939) = 4.68$ in.

Next find the scale factor S. Assume the 10-in. base radius circle, *Fig.* 1, will be used. Then $S = 10/2.34 = 4.27$. If 4.27 is sufficient enlargement, the constants may be calculated to the enlarged scale. Multiplying a and b by 4.27 gives $a = 1.28$ and $b = 0.747$ for the layout. Clearance $c = (0.3/P)4.27 = 0.321$. Fillet radius $= c = 0.321$. Pitch diameter is 21.35 in.

Use tracing paper on which to draw the layout. First draw an arc representing the base circle at the 10-in. radius and another representing the pitch circle of 10.67 in. radius. Calculate tooth thickness from

$$t_p = S\left[\frac{\pi}{2P} + (\Delta a)\ 2 \tan \phi\right]$$

Then

$$t_p = 4.27\left[\frac{\pi}{8} + \left(\frac{1.2}{4} - \frac{0.8}{4}\right) 2 \tan 20 \text{ deg}\right]$$

$$= 4.27\ [0.3927 + 0.1\ (0.728)]$$

$$= 4.27\ (0.4655)$$

$$= 1.988 \text{ in.}$$

Derivation of the equation for t_p is by com-

Nomenclature

a = Addendum, in.
b = Dedendum, in.
c = Clearance, min., in.
D_p = Pitch diameter, in.
Δa = Long addendum minus standard addendum, in.
h = Height of beam (from critical section to point of load application), in.
N = Number of teeth
P = Diametral pitch
p = Circular pitch, in.
ϕ = Pressure angle, deg
r = Fillet radius
S = Scale factor
s = Stress in tooth, psi
t_b = Tooth thickness at base circle, in.
t_p = Tooth thickness at pitch circle, in.
W = Load, lb

parison of the involute profile with a standard rack.

After marking the points corresponding to the tooth thickness on the pitch circle, lay the tracing paper over the standard involute curves, *Fig.* 1. Let the arc representing the base circle coincide with the 10-in. radius base circle, and the point representing one limit of tooth thickness lie on the standard involute curve. Trace the involute curve.

Flip the tracing paper over and trace the other tooth face (mirror image) on the opposite side of the paper. Draw the fillets, root circle and addendum circle, *Fig.* 2, using the previously calculated constants.

Although this example illustrates use of the method for laying out a special long addendum tooth, it may be applied as well to any involute profile.

Beam strength may be easily computed from the full-size layout, *Fig.* 2, by merely scaling off the necessary dimensions. For example, with a load W of 1000 lb, find s from

$$s = \frac{6\,Wh}{t_b^2}$$

From *Fig.* 2, $h = 1.65$ in.; $t_b = 2.15$ in. After dividing each of the quantities by the scale factor,

$$s = 4.27\,\frac{6\,Wh}{t_b^2}$$

$$= 4.27\,\frac{6(1000)(1.65)}{(2.15)^2}$$

$$= 9189 \text{ psi}$$

Suitable velocity and fillet stress concentration factors may be used for more exact calculations.

Fig. 1—Below—Reference involute curves drawn for five representative base radii

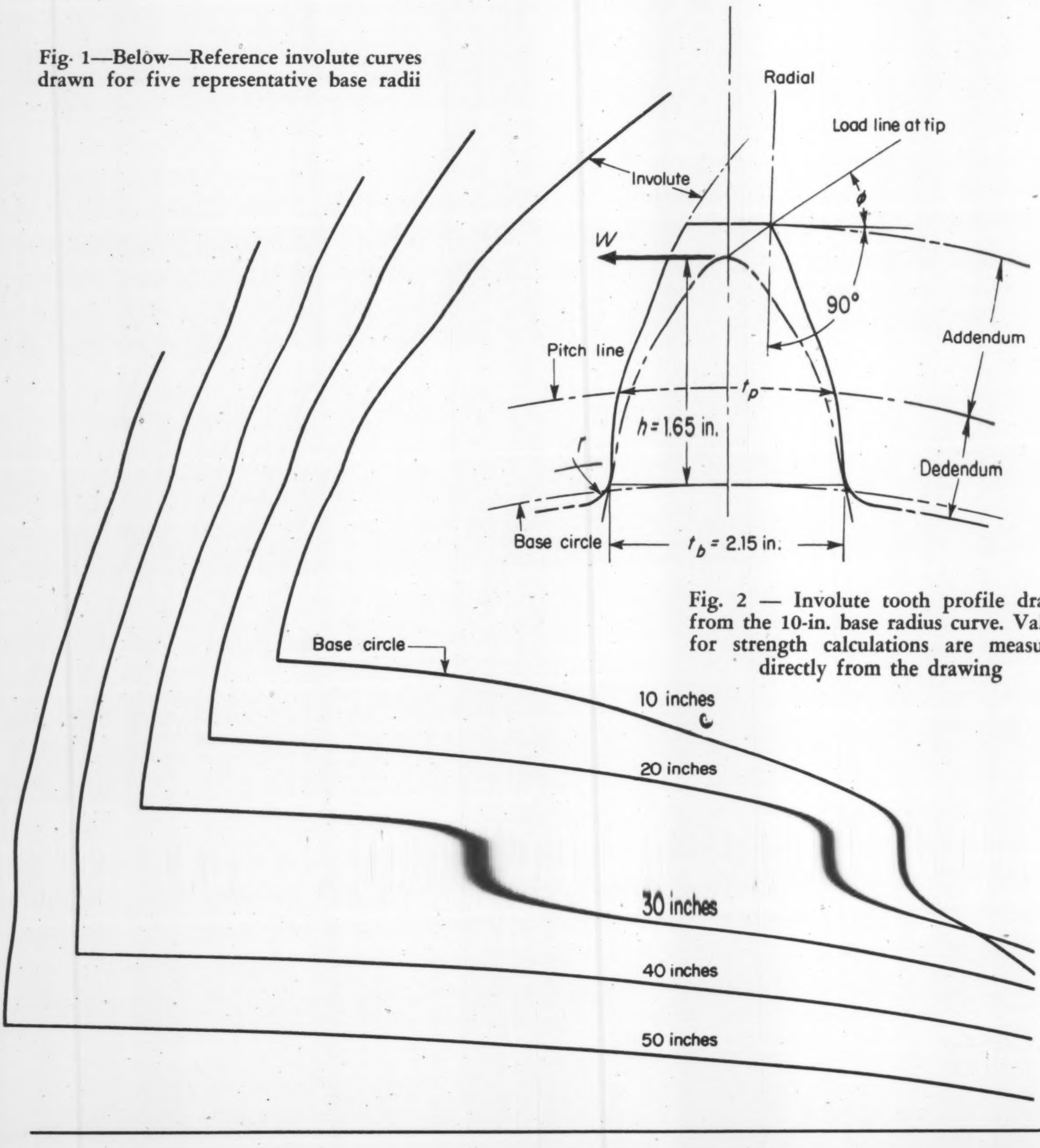


Fig. 2 — Involute tooth profile drawn from the 10-in. base radius curve. Values for strength calculations are measured directly from the drawing

DESIGN ABSTRACTS

Recognizing and developing

Creative Potential

By John E. Arnold
Professor of Mechanical Engineering
Massachusetts Institute of Technology
Cambridge, Mass.

YOU cannot tell, by examining the end product, whether it was obtained by means of creative activity or by means of more prosaic, routine methods, or even by pure chance. And, you cannot tell, by looking at the types of problems that men set for themselves, whether they are creative or noncreative. The great scientists of the past and the present are great because they attacked their analytical problem with great daring and imagination. The hypotheses they proposed, and the tests they devised to verify these hypotheses, were conceived with bold, sensitive, flexible, novel thinking. Unfortunately, it is also possible to arrive at satisfactory answers to the multisolutional, creative type of problem by extremely prosaic, nonimaginative, noncreative means.

> ***". . . all men are born with a very definite . . . potential for creative activity."***

Creative Potential: My effort, for the last few years, to help myself and others realize to the full their own creative potential, is based on four hypotheses. First, all men are born with a very definite, though limited, potential for creative work. Second, this potential is at least partially independent of any other mental potential we may inherit. The third hypotheses is that the creative process in itself is unique. It is the same whether it expresses itself in art, music, poetry, business, engineering, or in housekeeping. The fourth hypothesis is that creative potential can be realized through training and exercise, just as the development of our full capabilities along analytical lines can be obtained.

Attributes of the Creative Individual: Now, what are some of the attributes that define or describe the creative individual? In general, they fall into two categories—mental and emotional. The creative person is more "sensitive to problems" than the noncreative person. He can see need areas that require attention long before the less sensitive person. He not only has the ability, but he enjoys searching in the dark areas and leaves the work in the well-lighted places to his less imaginative brethren. He has developed a constantly questioning attitude, a healthy skepticism, rather than a complacent acceptance. The questions he asks and the problems he poses for himself are stated in such a way that they do not limit or confine his thinking or actions. Correct problem statement is basic to succesful creative activity. Incorrect problem statement can precondition the thinking and preclude desirable solutions. It also can have a tremendously inhibiting effect on three other mental attributes: fluency, flexibility and originality.

> ***". . . creative potential can be realized through training and exercise . . ."***

Fluency of Thought: The creative person is more fluent in his thinking than the noncreative person. He has more ideas per unit time than others. Obviously, they are not all good ideas. But when he completes his list of alternatives, the probability is very high that there will be one or more ideas that are novel and that will solve his problem better. While it is very doubtful that quantity breeds quality, my experience has been that those who have lots of ideas, usually have the best ones.

Evaluation must be restrained temporarily while one is thinking up hypotheses or ideas and, in the same way, the limitations of the problem should be temporarily forgotten. This applies to economic limitations just as is does to mechanical feasibility or to the adaptability of man or machine. Fluency then, ties in with correct problem statement. But even with a highly restrictive problem statement, fluency can be obtained if the limitations are relaxed for a short period of time.

Flexibility of Thought: Flexibility of thinking reflects itself in the wide variety of approaches that the creative person chooses to investigate. The noncreative person's past experience provides him with a comfortable little rut in which to operate, and he has great difficulty getting out of that groove.

> ***"Correct problem statement is basic to successful creative activity."***

One of the worst examples of rigidity of thinking that I see as I go around and talk to and work with various industrial groups is the way in which they limit the design and research activity to only one or two of the four broad areas in which design activity can take place. Products or machines can be improved by increasing their function, by making the item do more than it did before, or by making it accomplish its prime purpose by an entirely new approach. The performance level of a product can be raised by making the product longer lived, more reliable, more accurate, safer and more convenient to use, and easier to repair and maintain. The cost may be lowered by eliminating excess parts, substitution of cheaper materials, cheaper and more efficient manufacturing methods, designing for convenience of assembly, designing to reduce hand labor or for complete automation. Last, products can be improved by designing for increased salability, that is, improving the appearance by making the product, its package and its point of sale more attractive, and by having a better appreciation of public wants.

"Evaluation must be restrained temporarily while one is thinking up hypotheses or ideas . . ."

Originality: The creative person thinks of more unusual, more unique solutions to problems than the noncreative person. He apparently has the ability to associate rather wide and seemingly unrelated ideas and synthesize them into a new, unusual solution. He has the ability to penetrate very deeply to remote regions. He can break down the seemingly natural boundaries within his own mind, so that his experience, instead of being pigeon-holed, is completely and carefully cross referenced. The creative person, then, is more sensitive to problems, he is more fluent and flexible in his thinking, and he is more original in the solutions he arrives at. We might say, he is better able to question, observe, associate and predict.

Emotional Attributes: The mental attributes listed are necessary, but not sufficient to the creative personality. Along with them there are a number of emotional attributes that many, I am sure, would list as primary rather than secondary. First of all, a man must be motivated before he will begin to attempt to solve any kind of problem, analytical or creative. We have ample evidence that over-motivation is extremely disastrous, in that it inhibits creative activity, but I am afraid that more of us suffer from under-motivation rather than over-motivation. Passivity is probably the original sin, and initiative is what most of us lack, for once into a problem, most of us can generate enough interest to keep us going until the problem is solved.

"Creating . . . also involves destroying . . . a present, possibly adequate solution."

Willingness to take a chance, to gamble, may be another form of initiative. But it is an important aspect of the creative person's personality. The creative person has to be daring. He has to be a leader in his group for society, and he must constantly take calculated risks in his attempt to find better solutions to the problems that face mankind. He cannot stick to the safe, the tried and true, the prosaic approaches, and he must pioneer in new areas in a very daring fashion. Creating, unfortunately, also involves destroying. The man who is seeking a new, better solution to an old problem is doing so, in part, because he wants to destroy a present, possibly adequate solution.

". . . progress is made through failure as well as through success."

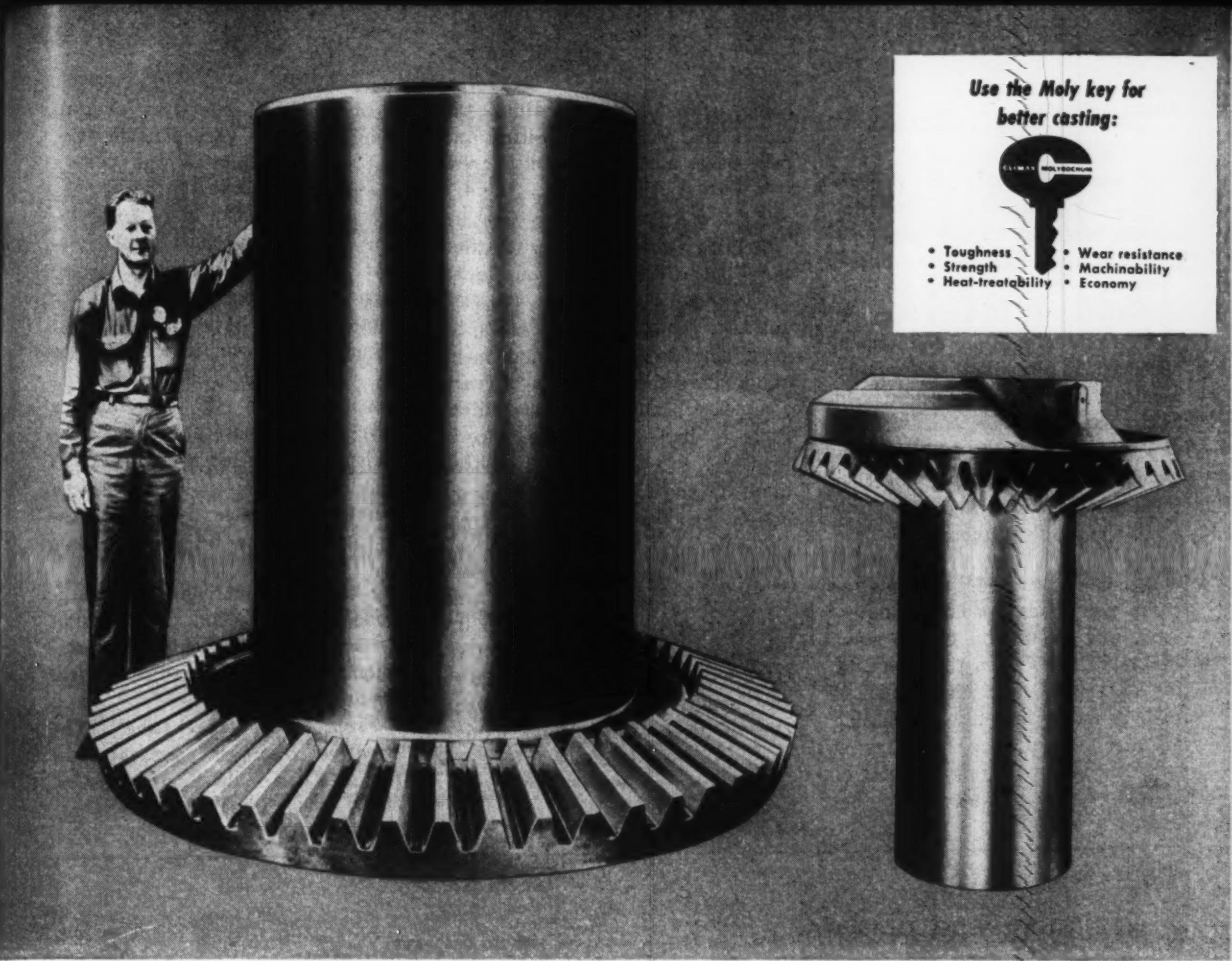
Properly motivated and willing to take a chance, the creative worker must, in addition, have self-confidence in his own ability to come up with a new and better solution. This is an extremely important emotional attribute and can only be developed through experience and exercise. It has been said that nothing breeds success like success, and this is probably true, but the corollary that failure breeds failure need not be true. If, through continued application, failures can be corrected, high orders of self-confidence can be developed. Actually, the fear of making a mistake is a very devastating emotional block to creative activity. People should realize that progress is made through failure as well as through success. I have had better success in training creative designers by helping them develop this spirit of self-confidence than I have in imbuing them with special design techniques or tricks of the trade.

The last emotional attribute I will mention here is drive. Many people have indicated that they feel that this is the prime requisite of all creative workers. Edison, for example, has said that invention is 10 per cent inspiration and 90 per cent perspiration. I am not sure that he has the percentages accurately distributed, but I do know that there is a great deal of work associated with the polishing and repolishing of an idea before it becomes an acceptable, tangible result.

Developing Creative Potential: The steps in the creative process have been listed as: question, observe, associate, and predict. And that last term, predict, covers a multitude of concepts, for it includes not only communicating your ideas to someone else, but communicating them in a tangible form which requires initiative, daring, self-confidence, and tremendous drive. Many of the best ideas had to be sold under extremely unfavorable conditions, and this is no easy job. To do it requires faith, not only in yourself, but also in the worthwhileness of your project. Keen anal-

"The creative person . . . is better able to question, observe, associate and predict."

Facing Page—ITEM 607→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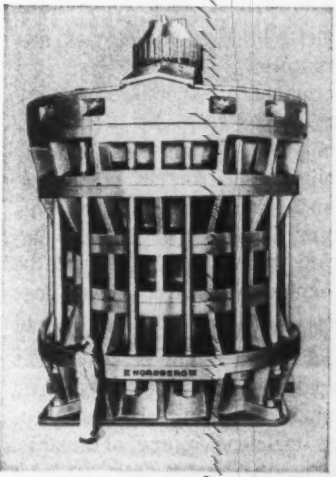
Cast Manganese Moly Steel contributes strength and toughness to Crushers built by Nordberg



The Symons Cone Crusher is a product of Nordberg Manufacturing Company.

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ysis, keen judgment, help provide and bolster this faith, and so they are as essential to this phase as they are to the idea-getting phase.

Check lists and attribute listings are useful in increasing our powers of observation, and also in association. Reading and experimenting in a number of different fields increases the sum total of experience on which we can draw when we wish to bring together these new patterns and configurations that better solve some need of man. Continual exercise of these powers is absolutely necessary, and we should try to solve every problem, when time permits, in as creative and imaginative a fashion as we possibly can, listing all alternatives, and then trying to select the best one. And, of course, we should all try to become aware of any or all of the blocks that may be inhibiting and preventing our most effective creative work.*

Helping Others Develop Creative Potential: What can you do to help others realize their creative potential and exercise it for the good of man? The management of creative personnel is a very complex problem, and, unfortunately, little concrete evidence is available to guide us. I do believe, however, that management has five responsibilities to the creative person. It must stimulate, encourage, assist, recognize and reward the creative person in order that he be most productive, though it is difficult to lay down any general rules for doing any one of these things and having them equally effective on all people. People vary considerably, and what stimulates one person may over-stimulate the next.

Some people can work to stringent deadlines; other people narrow their fields to such a degree that only commonplace results are obtained. One general rule might be made, however, and that is to try to establish a permissive atmosphere, one that establishes psychological safety and psychological freedom for the workers in that area. Psychological safety can be established by three associative processes: First, by accepting the individual as of unconditional worth; second, by providing a climate in which external evaluation is absent; and third, understanding emphatically.

From a paper entitled "The Creative Engineer" presented at the ASME Annual Meeting in Chicago, November, 1955.

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*J. E. Arnold—"Personal Development." MACHINE DESIGN, Vol. 28, No. 1, January 12, 1956, Page 95.

Designing and applying

Permanent Magnet Rotors

By Frank S. Greenwald

Director of Engineering
Indiana Steel Products Co.
Valparaiso, Ind.

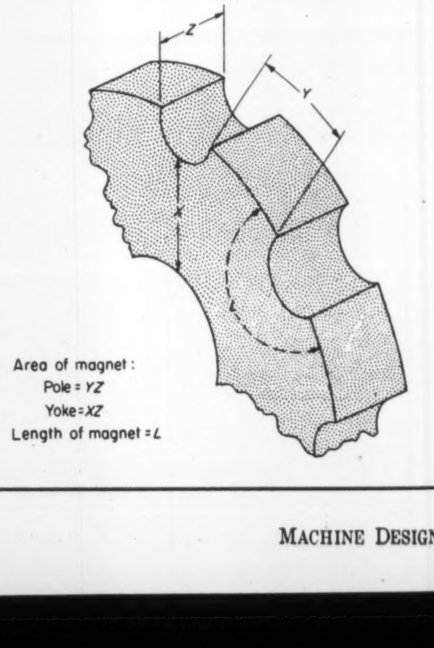
PERMANENT-MAGNET rotors are found in magnetos, eddy current devices, tachometer generators, synchronous ac motors, magnetic brakes and clutches, and alternators.

Permanent-magnet rotors require no external dc excitation. Elimination of the commutator simplifies construction of the rotor and reduces maintenance. This feature is also particularly important where arcing might be an explosion hazard. Power loss resulting from I^2R heating in wound rotors is not present. Heat dissipation from the rotor becomes a minor problem. Higher electrical efficiencies are obtainable. Considerable overall economies can result when the equipment must be portable or remotely located.

Magnetic design calculations require determination of both the length and the area which the magnet is to have. These dimensions are illustrated in Fig. 1. It will be seen that the flux passing through the yoke is equal to one-half of the pole flux, plus leakage flux.

Salient-pole rotors are usually preferred over those having a smooth outside diameter. The pole definition is sharper and it has been found that voltage regulation is better. A smooth OD, however, has certain manufacturing advantages. It can be ground more economically. The tendency to crack is markedly reduced. This shape is preferred when the ID is relatively large as compared to the

Fig. 1 — Dimensions for magnetic design



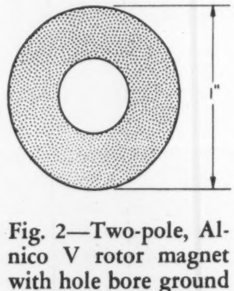


Fig. 2—Two-pole, Alnico V rotor magnet with hole bore ground for press fit on shaft

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OD. Many rotors using steel inserts cast into the magnet are practical only with a smooth OD. Even with salient poles the cracking problem can be lessened by increasing the section between the ID and the base of the slot.

Grade of Material: Choice of material grade for the magnet is influenced by manufacturing, as well as magnetic, considerations. As in nearly every other application, the first choice is Alnico V when the design will permit its use. In many rotors the limitation on magnetic length prevents using Alnico V at its peak energy output. In these cases Alnico VI is the next choice. Nearly all two-pole rotors can make efficient use of one of these grades, Fig. 2.

Alnico is very hard, brittle and mechanically weak. Because of its high shrinkage from the molten state, it tends to crack through thin sections or wherever there is an abrupt change of section. These characteristics determine the sizes and shapes which can be manufactured economically.

Both Alnico V and Alnico VI are anisotropic. This means that, to achieve full properties, the magnets must be cooled in a magnetic field during heat treatment. The configuration of the field has to correspond to the direction which the flux will take in the final application. Whenever the number of poles is four or more, special orienting fixtures are required to produce a magnetic field of the proper shape. If the number of poles is too great for the diameter of the rotor, these orienting fixtures interfere with proper heat-treatment, giving reduced magnetic properties. In such designs the Alnico grades which do not require orientation are recommended.

Generally speaking, either Alnico V or Alnico VI is satisfactory for four-pole and six-pole rotors. When the diameter is more than 2 in., even eight poles are practical. On the other hand, when the diameter is too small (less than ¾-in.) four poles may be too many for optimum heat treatment. Alnico II and Alnico IV are the isotropic grades used when neither Alnico V or Alnico VI is practical. Alnico II gives more air-gap flux than Alnico IV, except when the magnetic length is severely limited. Alnico IV has somewhat greater physical strength than the other grades, and, for this reason, is preferred in some rotors. Configurations for typical eight-pole and six-pole rotor magnets made of Alnico IV and VI, respectively, are shown in Figs. 3 and 4. A two-pole, Alnico II rotor assembly is illustrated in Fig. 5.

Attaching Magnets to Shafts: The magnet designer has his choice of several means for attaching the magnet to its shaft. Each method has advantages and limitations. The following is a list of these methods with a brief description:

1. The ID of the magnet could be ground so that the shaft might be pressed directly into the magnet. This method is rarely used. The bore grinding which must be done on the magnet is extremely expensive. Furthermore, because of the brittle nature of Alnico, pressing in the shaft tends to break the magnet.

2. A steel shaft could be cast directly in the magnet as an insert. This method is seldom used. Since the shaft must be subjected to the high temperatures which are used in processing Alnico, it becomes warped and heavily scaled. The shaft must therefore be machined after the magnet is heat-treated. This machining would be much less expensive if it were done without the magnet in place. Furthermore, the shaft extends from the magnet and thus tends to reduce the capacity of grinding machines and heat-treat equipment.

3. A steel insert might be cast into the magnet. This insert would then be bored and reamed for a press fit on the shaft. This method is used to a considerable extent. It has the disadvantage that the insert tends to cause cracking in the magnet. The insert often must be nonmagnetic stainless steel for magnetic reasons, although it is possible to use cold-rolled steel in some multipole rotors.

4. The magnet could be cast with a cored hole into which a brass insert would be soldered after the magnet has been heat-treated. The insert would be drilled and reamed as in the previous method. This is also a popular method, particularly where the use of a steel insert would cause excessive cracking. On the other hand, the added soldering operation increases the cost of producing the magnet.

5. The magnet could be cast with

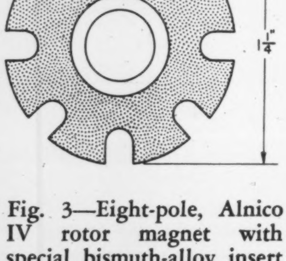

Fig. 3—Eight-pole, Alnico IV rotor magnet with special bismuth-alloy insert cast in cored hole

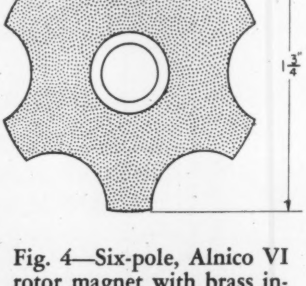

Fig. 4—Six-pole, Alnico VI rotor magnet with brass insert soldered in cored hole

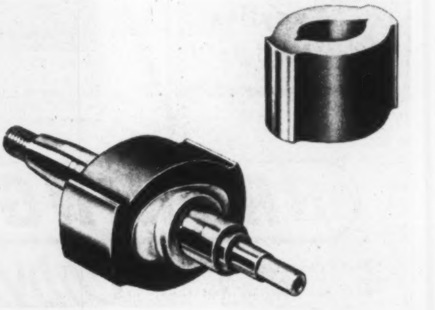

Fig. 5—Two-pole, Alnico II rotor magnet and assembled rotor with shaft die cast in irregular cored hole

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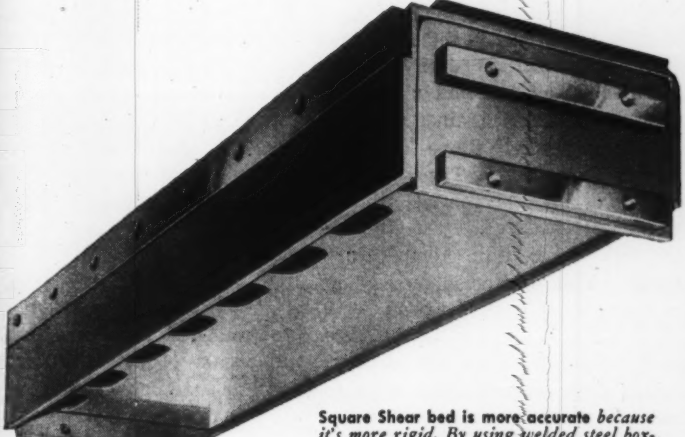

Square Shear bed is more accurate *because it's more rigid. By using welded steel box-type construction, deflection under load is cut 60% over conventional cast iron design. Cost of construction is 28% lower than if made from castings. Photo courtesy Famco Machine Company, Kenosha, Wisconsin. View is from underside to show design details.*

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a cored hole into which a special soft alloy material could be cast to take the place of the brass insert. This method does not require soldering, but this advantage must be balanced against the fact that the special alloys are relatively expensive. These alloys contain a high percentage of bismuth and expand upon cooling through a certain temperature range. This expansion on cooling is essential if a tight insert is to be obtained in a round hole. There is a limitation on the use of these alloys since some of them begin to soften when the temperature exceeds 200 F.

6. The shaft might be die cast in place after the magnet has been heat treated. Because costly tooling is involved, this method is limited to high-volume applications. It is usually necessary that the hole in the magnet be of an irregular shape to give a keying action. Otherwise, the aluminum or zinc would shrink away from the magnet and give a loose insert. In normal practice the insert is designed so that it extends beyond the ends of the magnet to give a clamping effect as it shrinks.

7. The magnet might be produced with a cored hole and then merely clamped against a shoulder on the shaft using a nut at the other end of the rotor. This method makes it difficult to hold concentricity and is generally limited to experimental units.

Assembled Rotors: As pointed out earlier, Alnico is mechanically weak. This limitation makes a single magnet casting unsuitable when the rotor is to be particularly large. Although a sharp dividing line cannot be drawn, an assembled unit is recommended if the diameter is to be greater than 3 or 4 in. Figs. 6, 7, and 8 illustrate typical constructions. The mechanical strength of these assemblies is much superior to that which an individual magnet casting would have. The permanent-magnet material is used efficiently in the form of simple shapes which can be processed for optimum properties.

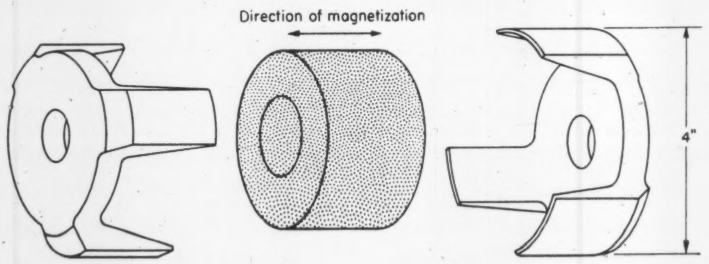

Fig. 6—Exploded view of Lundell rotor consisting of six-pole, Alnico V, axially magnetized magnet to be mounted on nonmagnetic shaft

The Lundell construction, Fig. 6, is particularly well suited to rotors having a large number of poles. The magnet is magnetized along the axis of the shaft with the interleaving pole pieces giving alternate poles on the OD. This simplification can be an important advantage. The magnetic leakage in these designs is normally greater than in other constructions.

Assemblies made as shown in Fig. 7 are almost always die cast into an aluminum or zinc housing. Many of the largest permanent-magnet rotors are made this way. The pole pieces of the assembly in Fig. 8 may be bolted to the central steel core through cored holes or slots in the magnet. Often these assemblies are held together by means of an aluminum die casting, either with or without bolts. When used, the bolts must be nonmagnetic stainless steel or brass.

Indox can be used to advantage in some rotor assemblies. Since no appreciable loss of flux is caused by magnetizing prior to assembly, the need for a special magnetizing fixture is eliminated. It is also not necessary to provide keepering if the rotor is removed from the stator. The high coercive force of Indox reduces the effect of armature reaction.

From "Permanent Magnet Rotors for Alternators" in Applied Magnetics, *published by Indiana Steel Products Co., March-April,* 1956.

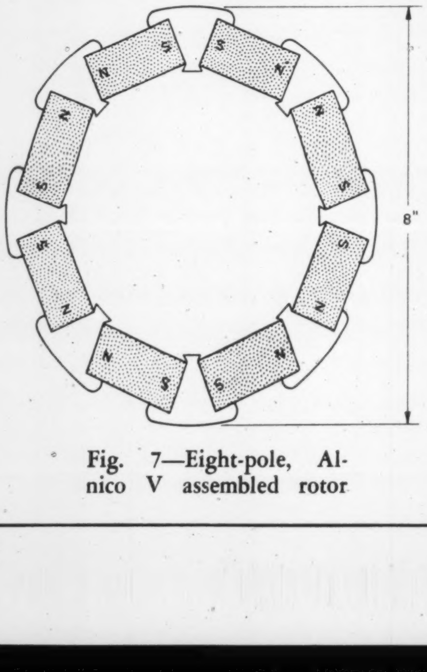

Fig. 7—Eight-pole, Alnico V assembled rotor

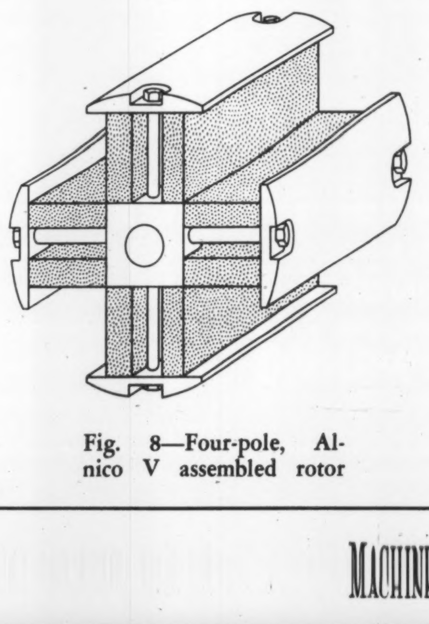

Fig. 8—Four-pole, Alnico V assembled rotor

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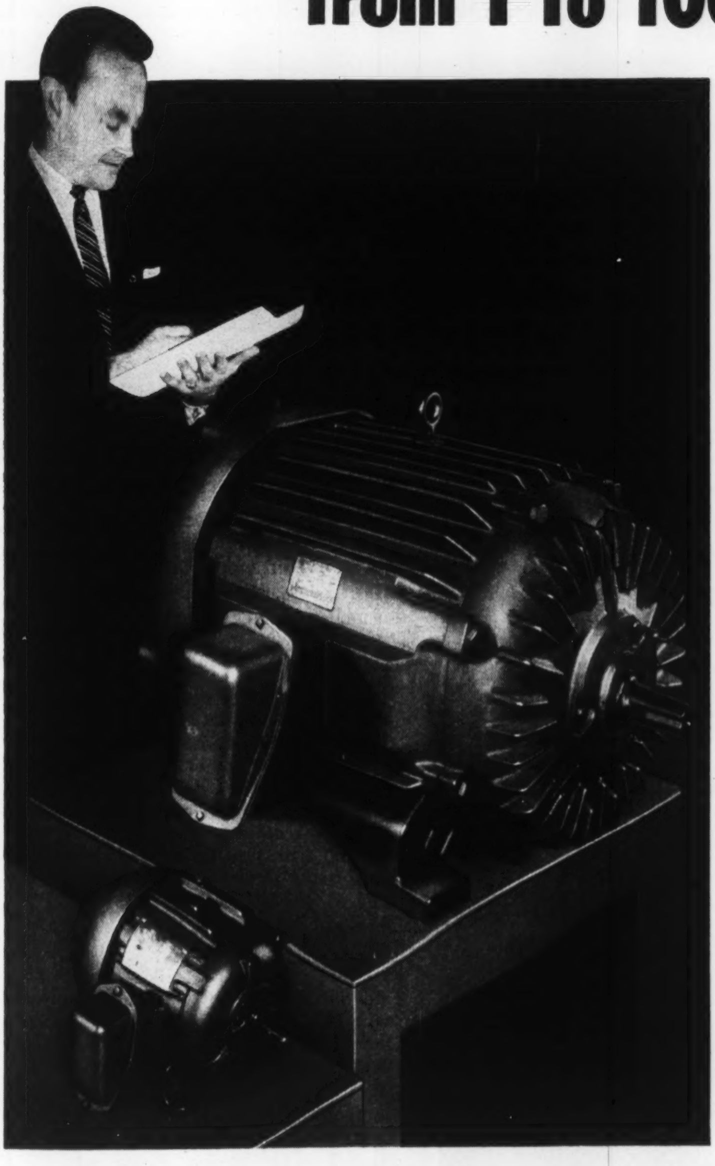

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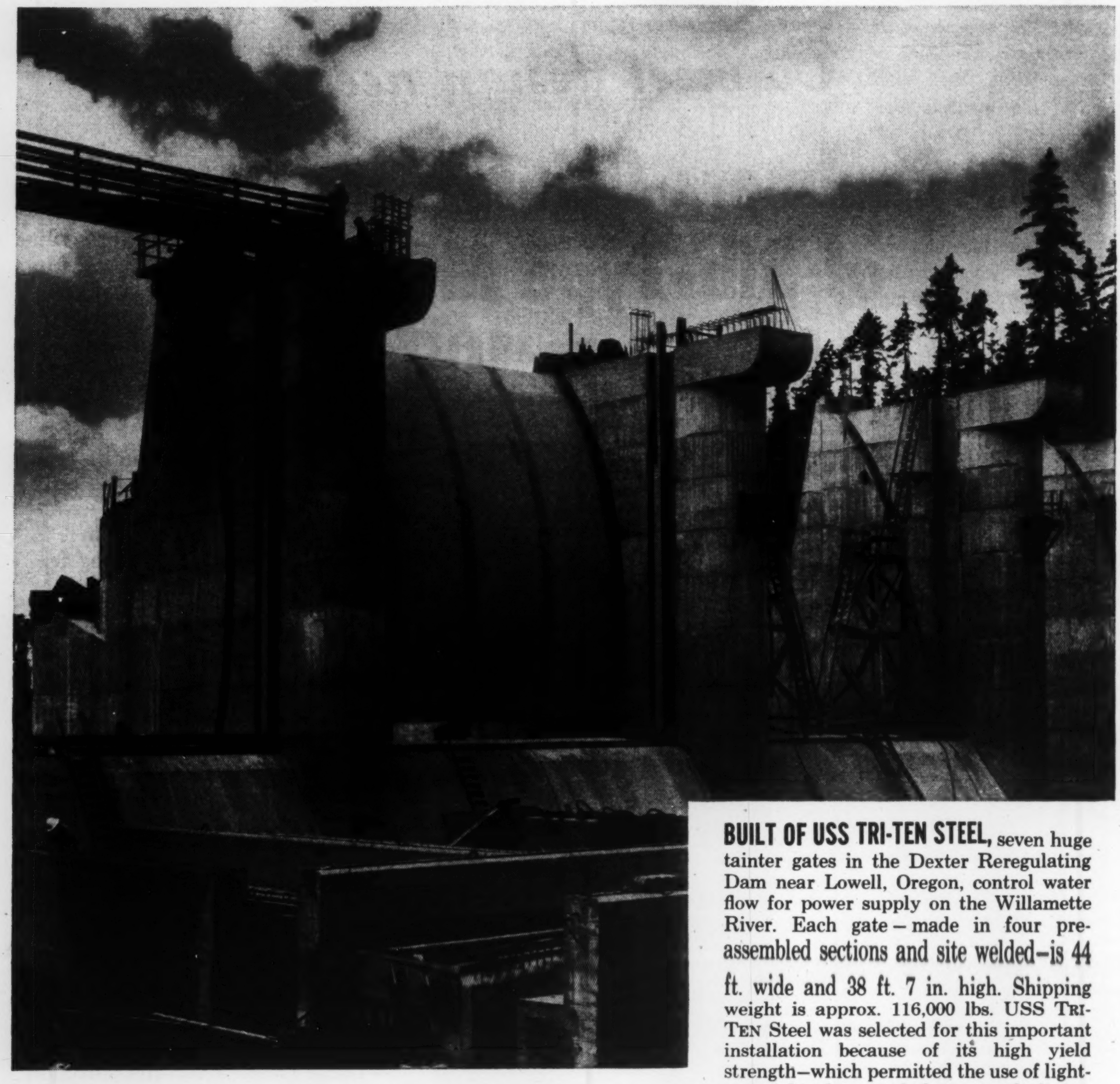
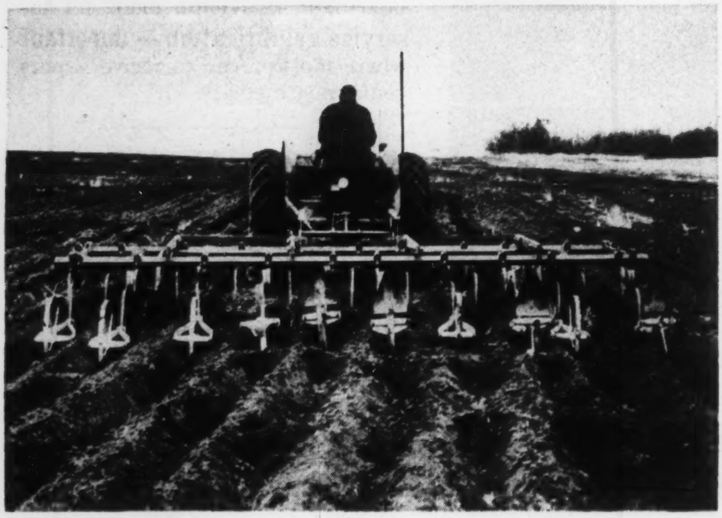


BUILT OF USS TRI-TEN STEEL, seven huge tainter gates in the Dexter Reregulating Dam near Lowell, Oregon, control water flow for power supply on the Willamette River. Each gate – made in four preassembled sections and site welded–is 44 ft. wide and 38 ft. 7 in. high. Shipping weight is approx. 116,000 lbs. USS TRI-TEN Steel was selected for this important installation because of its high yield strength–which permitted the use of lighter weight plates and shapes–and also on account of its higher corrosion resistance–equal that of copper steel. (Gates fabricated by Willamette Iron & Steel Co., Portland, Ore., for the Portland District of the Corps of Engineers.)

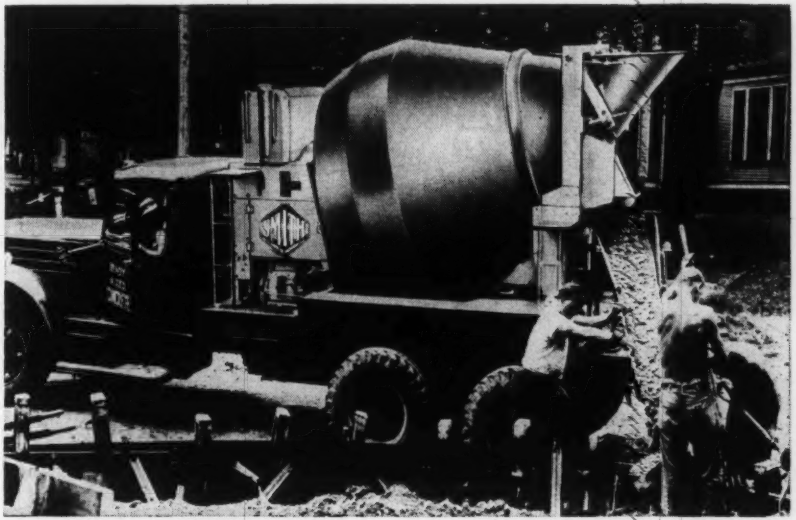


IN FARM EQUIPMENT, like this Rol-A Dam dammer built by Gunning Manufacturing Co., Lansford, N. D., the use of USS High Strength Steels in vital parts effectively increases life and dependability. Here, USS MAN-TEN Steel in the dammer blades provides superior abrasion resistance plus lightweight and extra strength and toughness. As one manufacturer puts it, "Because farm equipment takes terrific abuse in the field and is generally exposed to the weather without any protection whatsoever, we have found high strength steel construction a 'must'."

with USS High Strength Steels

GULF
Sanitary
REST ROOMS

CORROSION RESISTANCE is important in sign poles like this manufactured by C. J. Glasgow Company, Detroit, Mich. Due to the method of construction and design of upright and sign, the inside cannot be kept painted and is subject to corrosive damage. Built with USS COR-TEN Steel, which has 4 to 6 times the resistance to atmospheric corrosion of carbon steel, poles last 2 to 3 times longer. The higher strength of COR-TEN Steel also makes it possible to use steel in lighter gages, saving weight which reduces shipping costs and makes erection easier.



RESISTANCE TO ABRASION, plus the added strength and corrosion resistance supplied by USS MAN-TEN Steel, greatly reduce maintenance and add years of service life to the drum of this highly efficient concrete mixer, built by the T. L. Smith Company, Milwaukee, Wisc. MAN-TEN Steel's ability to resist the grinding action of stone, sand, slag and cement is so generally recognized that the use of MAN-TEN Steel in drums has become almost standard construction by leading manufacturers of truck mixers.

IN USS HIGH STRENGTH STEELS, design engineers have at their command three service-tested steels that will permit them to materially increase the efficiency and economy of machinery, equipment and structures at little or no increase in first cost . . . and frequently, at a saving.

All three of these famous "steels that do more" – USS COR-TEN, USS MAN-TEN and USS TRI-TEN – have a 50% higher yield point than ordinary carbon steel. All have better corrosion resistance and offer greater resistance to wear, fatigue and impact. Each, however, has specific superior properties that should be considered in determining its selection.

USS COR-TEN Steel, for example, is distinguished by its superior resistance to atmospheric corrosion–4 to 6 times that of carbon steel. USS MAN-TEN Steel is intended for weight reduction by means of greater strength in moderate forming applications, with enhanced resistance to abrasion and atmospheric corrosion. USS TRI-TEN Steel's outstanding characteristics are excellent weldability and resistance to shock at low temperatures.

Used singly or in combination, these steels can advantageously replace carbon steel to increase the strength and durability of vital parts *without* increasing their weight. Or when the use of thinner sections is feasible they can (1) reduce equipment weight without reducing its strength, or (2) increase the size and capacity of equipment without increasing total weight or the power required to move it.

You will find our 174-page *"Design Manual for High Strength Steels"* extremely useful in applying the benefits of these steels to your product. Send for free copy–simply write on your company letterhead to United States Steel Corporation, Room 5256, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

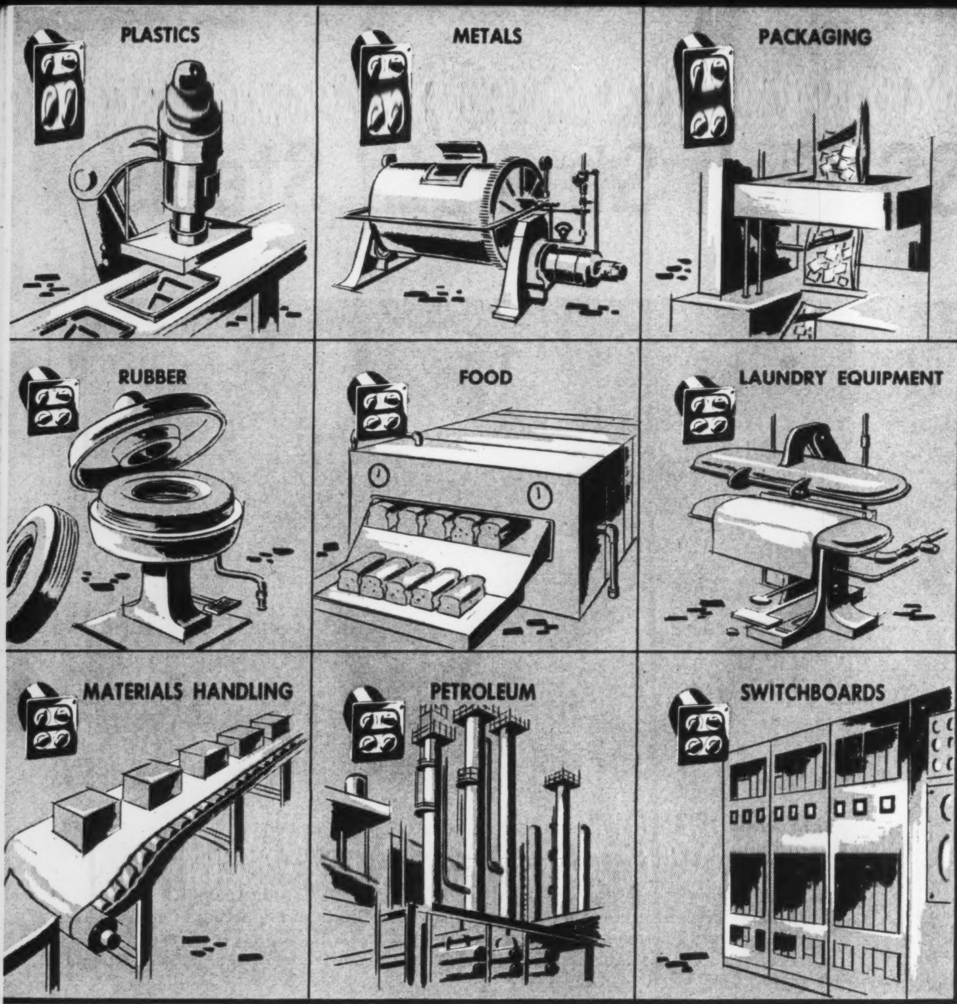
UNITED STATES STEEL USS HIGH STRENGTH STEELS
1933 1956
23 YEARS OF PERFORMANCE

USS HIGH STRENGTH STEELS

USS MAN-TEN · USS COR-TEN · USS TRI-TEN

UNITED STATES STEEL

—ITEM 611—
For More Information Circle Item Number on Yellow Card—page 19



In All These Applications . . .

3 NEW FEATURES OF G-E INTERVAL TIMER IMPROVE CONTROL AND CUT TIMING COSTS

To give you even greater versatility in time control, the General Electric TSA-18 interval timer may now be equipped with these optional features: new reset contacts, elapsed time indication and a program retaining mechanism.

NEW RESET CONTACTS make possible *either* automatic resetting or automatic recycling in the same timer. A simple change in external wiring is all that is necessary to change from one to the other. With *automatic resetting* you can eliminate manual resetting or mortgaging another circuit to achieve the reset action. With *automatic recycling,* the timer will reset at the end of a time cycle and immediately start the next cycle. This gives you a continuous repeating time-cycle program.

ELAPSED-TIME INDICATION, shown by a small dial on the timer face, gives you a continuous, accurate reading of time elapsed from the start of your time-cycle program—especially useful on long programs.

PROGRAM RETAINING: In case of power failure the program-retaining mechanism will hold the timer at the point of interruption and restart it at this point when power is restored. (Cannot be used in the same timer with reset contacts.)

MANY STANDARD "EXTRAS" are included in the TSA-18 timer: delayed on-and-off timing in intervals from 1 second to 30 hours; knob-locking device to prevent missetting; high setting accuracy of 1%; high repeat accuracy of ¼%; dust-proof case—*all standard at no extra cost.*

YOUR COSTS ARE REDUCED because the TSA-18 interval timer will increase the equipment operators can handle and free them for more productive activity. Waste or spoilage of materials can also be reduced, with the higher degree of uniformity that G-E timed control gives you.

For further information, contact your nearest General Electric Apparatus Sales Office, or write for bulletin GEC-1223 to Section 584-3, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

G-E TSA-18 TIMER WILL REDUCE COSTS IN ALL THESE OPERATIONS

IN PLASTICS

Automatic molding
Scheduled mixing of materials
Batch weighing

IN METALS

Heat treating
Flame hardening
Induction heater annealing
Quenching cycles
Firing of regenerative furnaces
Plating
Bath and soak cycles
Motor reversing cycles—tumbling
Batch weighing
Sequencial adding of materials

IN FOOD PROCESSING

Sugar centrifuge control
Dough mixing
Dehydration equipment
Automatic chicken pickers
Roasting processes
Motor reversing cycles—agitators
Adding ingredients in sequence
Infra-red oven control
Molding and pressing
Batch weighing
Bag folders
Heat sealers—plastic bags
Bag and box fillers

IN MACHINE TOOLS

Flame hardening
Heat treating
Resurfacing of grinding wheels
Final polishing intervals
Periodic lubrication

IN RUBBER

Tire and tube curing cycles
Injection period control

IN CHEMICALS

Motor reversing cycles—agitators
Atomic radiation control—setting exposure reading interval
Batch weighing
Sequencial adding of materials
Testing photographic emulsions
Infra-red oven control
Purging of filtration tanks
Dehydration equipment

IN CONTROL PANELS

Single time-interval operation
Multiple time-interval operation
Recycling of timed operations
Sequencial cycling of automatic machines
Motor-reversing cycles
Reclosing of circuit breakers
Unattended substation starting

AND MANY OTHERS

Transit-system scheduling
Glass polishing cycles
Spin and surge protection of deep well pumps
Automatic paint spraying devices
Photo copying equipment
Automatic door closing
Dry cleaning and laundry machines
Alarm initiation
Dust collectors and shakers
Quality control
Materials handling
Periodic test sampling

HELPFUL LITERATURE

for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Phenolic Molding Compounds

Phenolic resins and molding compounds bearing Durez name are described, their uses explained and methods of molding covered in illustrated brochure. Also included are section on choosing the right materials, physical properties chart, design suggestions and finishing data. 16 pages. Durez Plastics & Chemicals, Inc.

—Circle ITEM 401

Industrial Control System

"The Whys and Wherefores of Cypak" is an illustrated bulletin which describes Cypak industrial control system, its applications, function and purpose. Operating without relays or moving parts, it uses a logic function approach with four functions—and, or, not and memory. Any circuit function can be achieved. 6 pages. Westinghouse Electric Corp.

—Circle ITEM 402

Ceramic Coatings

Oxidation protection, improved mechanical properties and related advantages imparted to metals by ceramic coatings and porcelain enamels are tabulated and discussed in illustrated bulletin. Protective coatings are offered for ferrous and nonferrous metals and alloys, as are complete production facilities. 6 pages. General Ceramics Corp.

—Circle ITEM 403

Hydraulic Fluid

Factual information on the installation and maintenance of Houghto-Safe fire-resistant hydraulic fluid where potential fire hazards exist is presented in illustrated folder. Typical uses are outlined, and the advantages of this fluid are summarized. 8 pages. E. F. Houghton & Co.

—Circle ITEM 404

V-Belt Drives

Single and multiple groove pulleys, variable pitch pulleys, flexible couplings, link and standard V-belts, steel shaft collars and fans in a complete range of sizes for every need are listed in illustrated "V-drive Catalog and Engineering Manual" No. f-10. This well-indexed guide is packed with application data. 44 pages. Maurey Mfg. Corp.

—Circle ITEM 405

Automation Drive

"Select Your Automation Program" is title of bulletin that describes the ME AUTOmator that combines a dc power source with an adjustable speed dc motor to provide flexible and accurate speed for automation drives. Details of components are discussed. 8 pages. Marathon Electric Mfg. Co.

—Circle ITEM 406

Whiteprinting Machine

Century whiteprinting machine will reproduce anything typed, written, drawn or photographed on reasonably translucent material at speeds up to 70 fpm in 42 and 54-in. widths. Details of this machine and its use in design and engineering work are covered in illustrated bulletin 2506. 8 pages. C. F. Pease Co.

—Circle ITEM 407

Set Screws

The new Setko Jewel Case contains a complete assortment of set screws. It will be sent free on loan to design and production engineers to aid in solving problems. Full details of the Case and available set screws are presented in illustrated bulletin. 6 pages. Set Screw & Mfg. Co.

—Circle ITEM 408

Speed-Sensitive Switches

Dimensional drawings and application data on line of speed sensitive switches and overspeed governors are presented in illustrated bulletin 504S. One, two and three switch overspeed and underspeed governors are covered. 8 pages. Synchro-Start Products, Inc.

—Circle ITEM 409

Alloy Steel Screws

Socket head cap, socket cap, hollow set, hollow lock, square head set, slotted headless set, machine and cap, square head collar, tool post and special screws as well as stripper bolts, hollow pipe plugs and hex socket keys are described in illustrated booklet "Improved Product Design with Mac-it." 16 pages. Strong, Carlisle & Hammond Co.

—Circle ITEM 410

Brass Die Castings

How brass pressure die castings are produced, design data, value analysis versus sand castings, and composition and properties of brass die casting alloys are contained in illustrated bulletin. 4 pages. Titan Metal Mfg. Co.

—Circle ITEM 411

Subminiature Relay

The new 5-amp subminiature six-pole double-throw series 2005 relay which meets requirements of applicable military specifications is subject of illustrated data sheet. 1 page. Guardian Electric Co.

—Circle ITEM 412

Power Chucks

Design and application data on two and three-jaw universal and serrated chucks in 6 to 12-in. sizes are contained in illustrated bulletin "S-P Power Chucks." 4 pages. S-P Mfg. Corp.

—Circle ITEM 413

Use of Forgings

Advantages forgings offer to the designer, metallurgist, purchasing agent and management are stated in this booklet for those individuals responsible for recommending or specifying. Request "Management Guide to the Use of Forgings." 6 pages. Drop Forging Association.

—Circle ITEM 414

V-Belt Fasteners

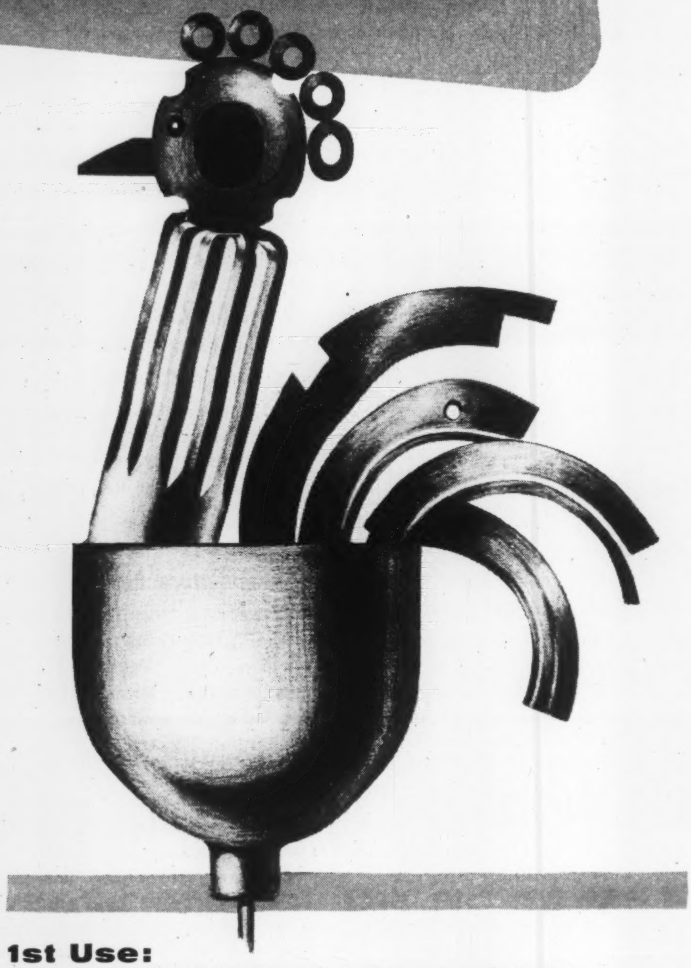
V-belt fasteners for open-end V-belting are subject of illustrated bulletin V-216. Details of use, applications, cost, ordering data and application tools are covered. 4 pages. Flexible Steel Lacing Co.

—Circle ITEM 415

Indicator Lights

Oil and dust-tightness, omnidirectional light spread and adaptability are features of compact series of in-

3 Morganite uses to crow about...



1st Use:

During 4½ years—and 19,000 steaming hours—in a chain grate stoker, *Morganite bearings required no lubrication and no maintenance.* Bearing wear was only 0.030" and the shafts were highly polished with negligible wear.

2nd Use:

Several hundred Morganite bearings, fitted to a 150 ft., double-roller, suspension conveyor, passed continuously through (1) caustic solution at 190° F, (2) water at 180° F, (3) Bonderite Solution at 190° F, (4) Chromate rinse at 180° F, and (5) a drying oven at 450° F. *After more than 17 years these bearings are still giving satisfactory performance.*

3rd Use:

In a 10-ton furnace charging machine, Morganite bearings have been operating in the "hot zone" for more than 3 years *without replacement or maintenance.*

If you have a problem involving severe temperatures, lubrication, or contamination, send us the details. Our Engineering Staff will be glad to work with you.

50th ANNIVERSARY TRADE MARK 1906 · 1956

Morganite INCORPORATED

Manufacturers of fine carbon-graphite products for fifty years.
3314 48th Avenue, Long Island City 1, New York

—ITEM 613—

dicator lights for heavy duty industrial uses. Illustrated brochure contains lamp drawings, dimensions and other data on incandescent and neon glow lamps. 4 pages. Dialight Corp.

—Circle ITEM 416

Industrial Filters

Filtration gives better control of quenching oil properties, according to illustrated folder on industrial filters and quenching oil applications. Operating data and case histories of Chain Belt and Borg-Warner installations are given. 4 pages. Industrial Filtration Co.

—Circle ITEM 417

Relief Valves

Pressure regulation from 100 to 2000 psi is available in ½, ¾ and 1¼-in. size relief valves and from 150 to 2000 psi in the 1½-in. size. Series M units are described, their specifications given and engineering drawings included in bulletin VR-3. 2 pages. Denison Engineering Co.

—Circle ITEM 418

Panel Instruments

Model 150 sealed and waterproof miniature panel instruments, described in illustrated bulletin M150, are 1½-in. diameter and designed for one hole mounting. Microammeters, ammeters, milliammeters and voltmeters are available. 2 pages. DeJur-Amsco Corp.

—Circle ITEM 419

Tube & Pipe Fittings

Fluid Fortress no-flare type and Griptube flare type of tube and pipe fittings are described in detail and their specifications given in this illustrated catalog 553. Feature is an alloy spring steel sleeve which holds excessive pressures without leakage. Types for various applications are covered. 28 pages. Flodar Corp.

—Circle ITEM 420

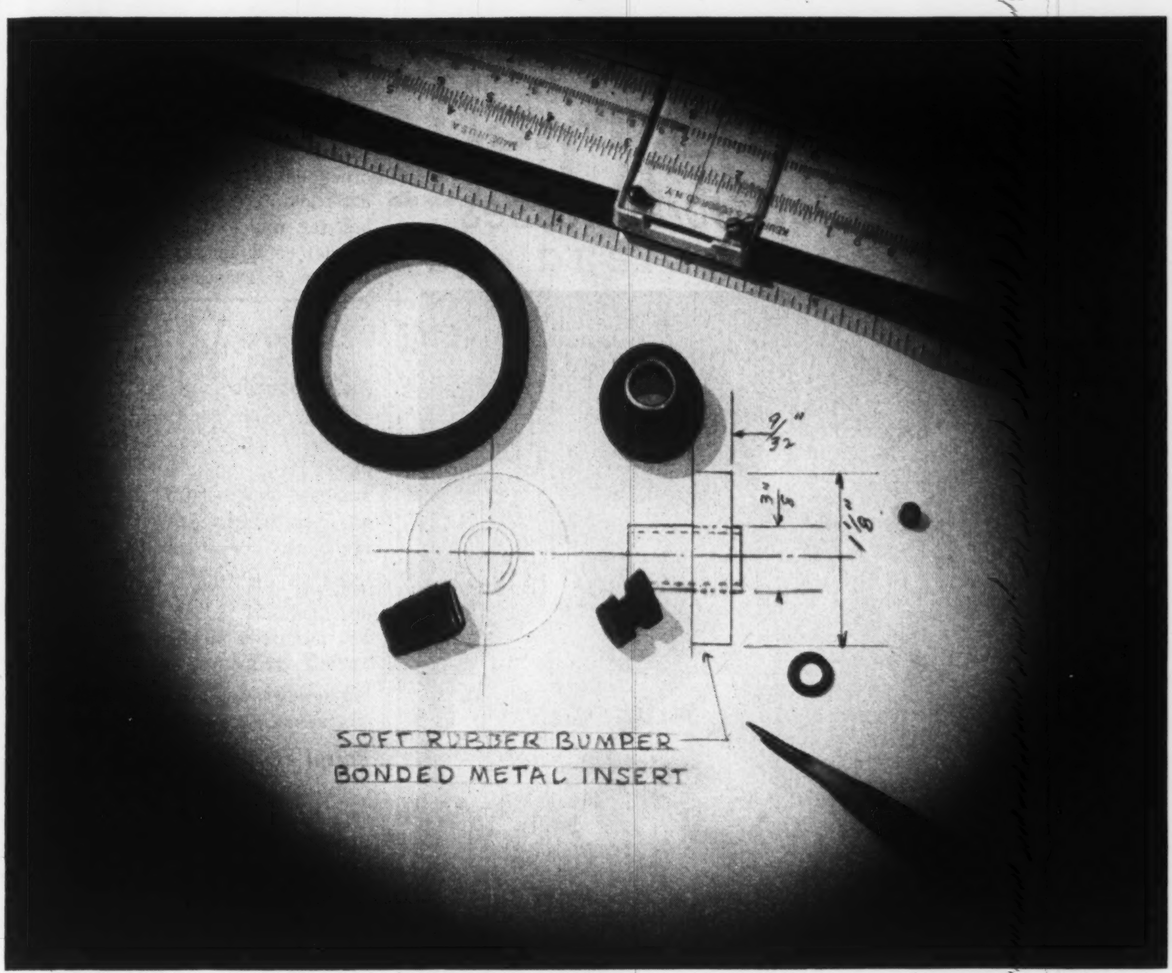
Net Weighing Machine

Packaging, bagging, batching and compounding of wide variety of products can be performed on the precision net weighing machine described in illustrated form 3287. Features of the fully automatic unit are given, along with general specifications for various models. 4 pages. Exact Weight Scale Co.

—Circle ITEM 421

O-Ring Seals

How to specify and use O-ring packings is covered in catalog 0100 which details synthetic, silicone,



Super soft rubber answers many problems!

SEALS! CUSHIONS! ABSORBS SOUND!

Here's an exciting new material formulated and developed by ROTH Rubber . . . a non-porous rubber with a softness from 5 Durometer up. Applications range all the way from a tiny, sound absorbing mounting ring used in a hearing aid to bonded conveyer belts where superior gripping and cushioning qualities are required. It may be the solution to *your* problem. Check the specifications, send the coupon for a free sample . . . ROTH will be happy to work with you.

PHYSICAL PROPERTIES—ROTH RUBBER COMPOUND D992

PROPERTY	UNAGED	AGED 70 HOURS						
		212F Air	212F #1 Oil	212F #3 Oil	200F Water	85F Isooctane	85F Type III Fuel	85F Naphtha
Hardness	7	27	30	1	8	9	5	9
Tensile Strength	500 psi	750	600	250	200	450	400	500
Elongation	800%	550	550	750	550	750	750	800
Compression Set	50%							
Volume Change	•	•	—36%	+90%	+25%	—17%	+20%	—2%
Cold Bend	—60F OK —65F Brittle							

Dielectric Strength measured on ⅛-inch thick slab: At 10,000 volts the rubber passes 2 microamperes of current; at 15,000 volts the insulation breaks down.

High Temperature Use—estimated limit 200F.

ROTH MOLDS AND COMPOUNDS RUBBER TO MEET ALL SPECIFICATIONS. TELL US YOUR PROBLEM. NO OBLIGATION!

ROTH

RUBBER COMPANY

1860 S. 54th Avenue, Chicago 50

Send for free sample OF THE RUBBER THAT FEELS LIKE SKIN!

Name________________________________Title________________

Company____

Address____

City____________________________________State__________________

—ITEM 614—

For More Information Circle Item Number on Yellow Card—page 19

"50% reduction in machining time...

finer finish...few scrap losses"

Aluminum valve housing for Chemox oxygen breathing apparatus.

As a sand casting, this part required twelve separate machining operations, with their inherent hazards of scrap losses, tool breakage and production delays. Made now as an investment casting by Precision Metalsmiths, only six machining operations are required.

Machining and machine-tool time are saved, finishes are very much better, and rejections have been reduced to practically zero.

In the above picture, one piece has been cut in half to show how complicated and accurate in details investment castings can be. Have your designers consider this highly flexible production method and find out how you can save time and money. We cast in 160 different ferrous and nonferrous alloys.

The book, *Pour Yourself An Assembly,* describes this versatile process. For a copy and for quotations on your investment casting requirements, write Precision Metalsmiths, Inc., 1083 East 200th Street, Cleveland 17, Ohio.

pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

—ITEM 615—

Helpful Literature

Teflon and leather Hi-duty seals. Engineering data, detailed specifications, installation drawings and other data are included. Covered are packings, gaskets, back-up washers for universal tube fittings and special compounds. 16 pages. Bay Rubber & Plastics Corp., Ohio O-Ring Div.

—Circle ITEM 422

Switchboards

"Switchboards with Basic Circuits" is title of illustrated bulletin which shows how eight classifications of standard switchboards are constructed, operated and tested. The "building block" concept as applied to the units is described. Basic circuit specifications in duplex switchboards are discussed in the bulletin, GEA-4127B. 40 pages. General Electric Co.

—Circle ITEM 423

Barrel Finishing Systems

Automated Sub-O-Matic submerged type barrel finishing systems for high production descaling, deburring, [illegible] grinding and burnishing are described in illustrated bulletin ABF-101. Details of operation, its programming feature, materials handling, layout and how compound savings are realized are covered. 12 pages. Queen Stove Works, Inc., Almco Div.

—Circle ITEM 424

Rolling of Metals

The Grotnes method of expanding, shrinking, and rolling metals is effectively described and illustrated in informative brochure. Typical sequences in forming a certain product are shown, as are many of the machines used in the process. 20 pages. Grotnes Machine Works.

—Circle ITEM 425

AN Connectors

22 x 27-in. wall chart is offered to help in specifying AN connectors for wide range of applications. Selection data covers number of contacts, contact size, voltage rating, creepage distance and spacing information. Other information covers insert insulation materials and shell finishes. Deutsch Co.

—Circle ITEM 426

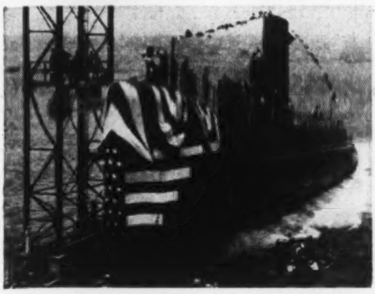
Rotary Swaging Machines

Typical examples of many operations performed by rotary swaging on solid or tube stock are illustrated in brochure on rotary swaging machines. Several models are shown with full specifications along with

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS



Atomic Sub Designers Save 4.5 Tons By Using Silicone Insulated Motors

The fact that you get more power per pound with Dow Corning silicone insulation has been proved in almost every kind and size of electric machine. But never has it been better demonstrated than in the atomic-powered "Seawolf" built by the Electric Boat Division of General Dynamics Corporation. Silicone insulation enabled Seawolf designers to reduce total motor weight by about 25%.

The Seawolf employs 63 integral horsepower motors to drive pumps, compressors and auxiliaries. These are in addition to the various motors already mounted on government furnished equipment.

Each of the 63 motors is completely insulated with Dow Corning silicones. Combined weight of these motors is 27,141 pounds. Motors built to supply equivalent horsepower but insulated with Class A or B materials would weigh an estimated 36,000 pounds. Thus, silicone insulation is responsible for a total weight savings of about 4.5 tons. This experience confirms again the fact that you get more power per pound from electric machines built with a Dow Corning silicone insulating system. ***No. 80***

"What's a Silicone?" is the title of a 32-page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. ***No. 81***

"Silicone Glass Parts by Vacuum Laminating" a reprint from MATERIALS AND METHODS, gives detailed procedures for making short runs of oversize, complex, or experimental parts without the expense of production mold; is supplemented with several illustrative photos. ***No. 82***

Silicone Paint Superior to Other Finishes for Trailer Bathtubs

With properties that overcome the limitations of both conventional organic finishes and vitreous enamels, silicone-based paints are helping designers engineer longer-lasting beauty and service into a broad range of products. One of the most recent examples is the finishing of housetrailer bathtubs by Sherer-Gillett Co. of Marshall, Mich.

The porcelain enamel formerly used on these cold-rolled steel tubs was expensive to apply, and necessitated an extra hand wiping operation to remove excess enamel from corners and edges. This coating added 25 pounds to each tub and often caused the metal to warp, resulting in high scrap losses. Porcelain finishing also meant high shipping costs plus the hazard of damage to tubs during handling.

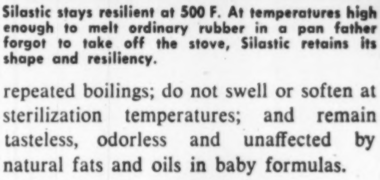
All of these problems have been eliminated by switching to a silicone-based paint. It is easily and efficiently spray-applied, and there is no longer any need for the costly hand wiping operation. This paint is cured by baking to give a high gloss finish that is flexible enough to withstand handling without cracking or chipping. Exhaustive lab tests and field experience have proved that it also has excellent resistance to alkali, acids, humidity and salt spray, and retains its original attractiveness after rugged service.

Sherer-Gillett's finishing process is simple and economical. Tubs are preheated for 30 minutes at 450 F to remove accumulated oil; then bonderized and sprayed with white Nubelon-S, a modified silicone-based finish formulated by Glidden. After a 30 minute bake at 425 F, the tubs are lightly sanded, wiped down and given a final spray coating and baking. ***No. 84***

NOW... SILICONE RUBBER NIPPLES

From traction motors to domestic steam irons — wherever product performance can be improved by rubbery materials that retain good physical and dielectric properties at temperatures ranging from —100 to 500 F—designers are finding new applications for Silastic*, Dow Corning's silicone rubber. Latest example is a nursing bottle nipple molded by Pyramid Rubber Co.

World's leading manufacturer in this field, Pyramid describes Silastic nipples as "the longest-lasting ever made." They withstand repeated boilings; do not swell or soften at sterilization temperatures; and remain tasteless, odorless and unaffected by natural fats and oils in baby formulas.



Silastic stays resilient at 500 F. At temperatures high enough to melt ordinary rubber in a pan father forgot to take off the stove, Silastic retains its shape and resiliency.

During months of hospital testing, Silastic nipples repeatedly lasted 15 weeks and more, or 5 times as long as conventional nipples. They are now an important item in Pyramid's "Evenflo" line. ***No. 83***

*TM REG. U.S. PAT. OFF.

Design Edition 20

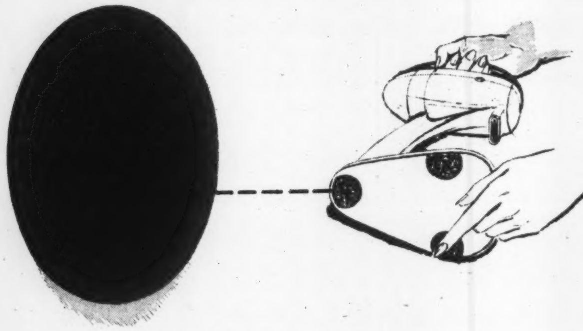
DOW CORNING CORPORATION · Dept. 6805
Midland, Michigan
Please send me **80 81 82 83 84**
NAME ______________________
TITLE ______________________
COMPANY ______________________
STREET ______________________
CITY __________ ZONE ____ STATE ________

ATLANTA • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C. (Silver Spring, Md.)

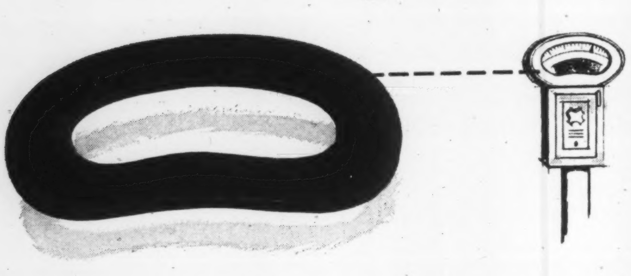
Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris

—ITEM 616—

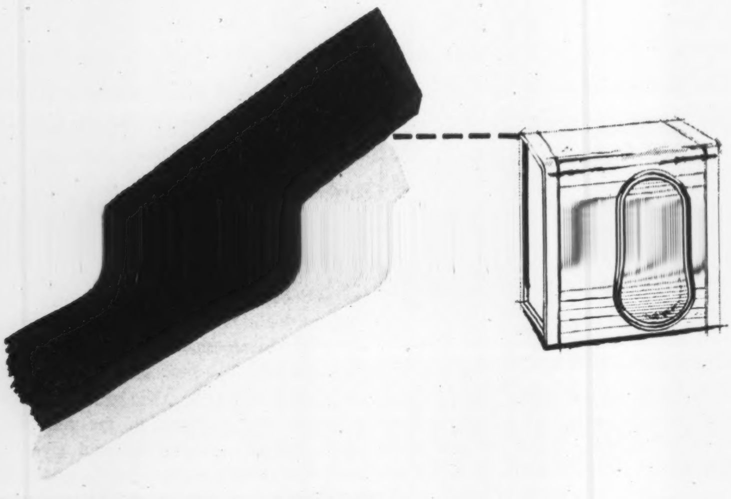
Prevents skids



Weatherproofs



Kills noise



It's Armstrong DK-153, a resilient cork-and-sponged rubber composition backed with a pressure-sensitive adhesive. This versatile material is now being used for hundreds of different industrial jobs . . . including skid-proofing electric mixers, keeping rain and dust out of parking meters, and quieting air conditioners. You can get Armstrong DK-153 in rolls, strips, sheets, or die-cut shapes, in thicknesses from 1/32 inch to 3/16 inch, with or without adhesive backing. In any form, DK-153 is easy to apply: just peel off protective covering and press material into place. For samples, write to Armstrong Cork Company, 7305 Dean Street, Lancaster, Pa.

PROTECTIVE BACKING
RESILIENT CORK-AND-RUBBER
ADHESIVE

Armstrong DK-153

. . . used wherever performance counts

—ITEM 617—

Helpful Literature

typical die designs. Production swaging is emphasized. 16 pages. Torrington Co.

—Circle ITEM 427

Noise Control

Up to 99.9 per cent reduction in noise level of air-operated equipment is achieved with series 4-44 Automufflers. Performance data on these pneumatic mufflers is graphically presented and typical installations are illustrated in bulletin "Noise Control." Mufflers are available for pipe sizes ⅛ to 2 in. 8 pages. Allied Witan Co.

—Circle ITEM 428

Fringe Area Lubrication

New concepts of extreme pressure or boundary lubrication in which solid Molykote lubricants perform a major function are described in folder 103. Eleven types of Molykote are listed and described according to their ingredients, working temperature ranges and method of application. 4 pages. Alpha Corp.

—Circle ITEM 429

Piston Packing Material

Engineering data on Darcova Pumcups for packing pistons of air cylinders, hydraulic cylinders and reciprocating pumps are presented in bulletin 5503. Data cover compositions, textures and types available for pressure, temperature and corrosive conditions. Range of sizes and prices are listed. 16 pages. Darling Valve & Mfg. Co.

—Circle ITEM 430

Controlling Corrosion

"How Zinc Controls Corrosion" is illustrated booklet which points out many ways zinc lengthens the life of steel products and reduces maintenance costs. Extensive selection of farm, industrial, marine and building applications of zinc is reviewed. Illustrations present corrosion control characteristics of zinc coatings, zinc pigments and zinc anodes. 32 pages. American Zinc Institute.

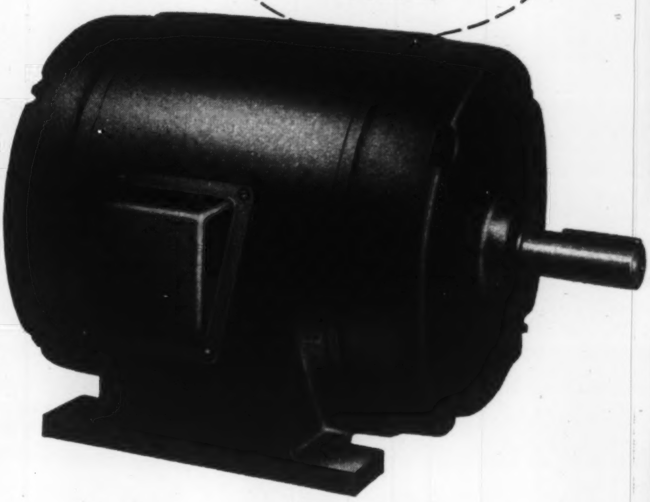
—Circle ITEM 431

Small Motors

Unidirectional, synchronous and reversible, as well as unidirectional and reversible, small motors for appliances, projection equipment, communications equipment, industrial instruments, displays, servomechanisms and toys are subject of descriptived data folder 4a/Ba. 4 pages Barber-Colman Co.

—Circle ITEM 432

Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

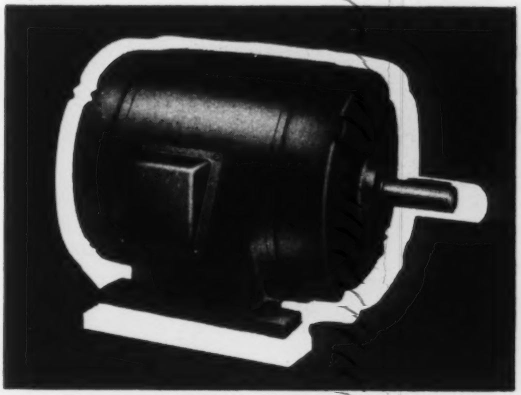


You get better performance with these Wagner DP Motors

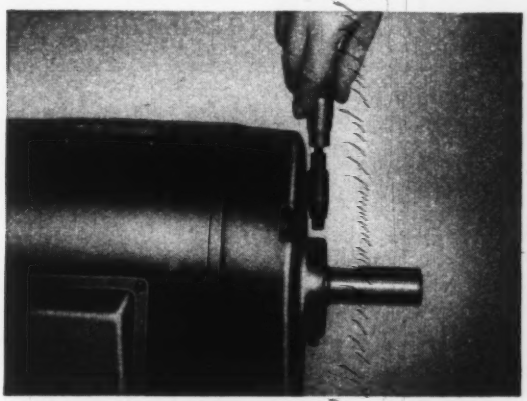
Wagner DP motors are *doubly protected* by (1) rugged, corrosion-resistant cast iron frames, smoothly rounded so that no moisture can collect on them. Motor feet are cast as an integral part of the frame for maximum strength and rigidity. (2) Enclosures on the DP motor are completely drip-proof—virtually splashproof. Air intakes are located at the bottom of the endplates and air outlets are located at the base of the frame—one on each side.

Although engineered to meet the re-rated NEMA specifications which call for more power in smaller frames, the same high quality and long life performance that have made Wagner Motors "the choice of leaders in industry" for many years has of course been retained.

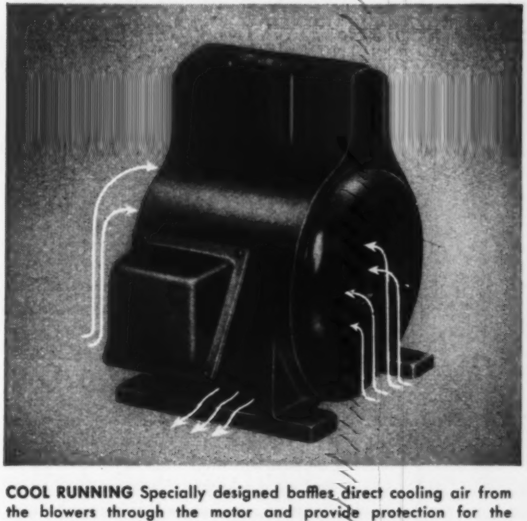
Full information and principal dimensions are given in Bulletin MU-202. Write for your copy today.



MORE POWER IN SMALLER FRAMES The Wagner DP Motor packs more power in a smaller frame and this smaller size means ease of handling and stocking... less space required for installation.



CAN BE RE-GREASED FOR LONGER LIFE This motor will operate for years without regreasing... bearings are completely enclosed ...however, provisions have been made for adding lubricant and for the removal of old grease in cases where re-greasing is necessary.



COOL RUNNING Specially designed baffles direct cooling air from the blowers through the motor and provide protection for the stator windings. Blowers are an integral part of rotor... and move large volumes of air without noise or vibration.

Wagner
Electric Corporation
EST. WEC 1891

Wagner Electric Corporation
6404 Plymouth Ave., St. Louis 14, Mo., U. S. A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

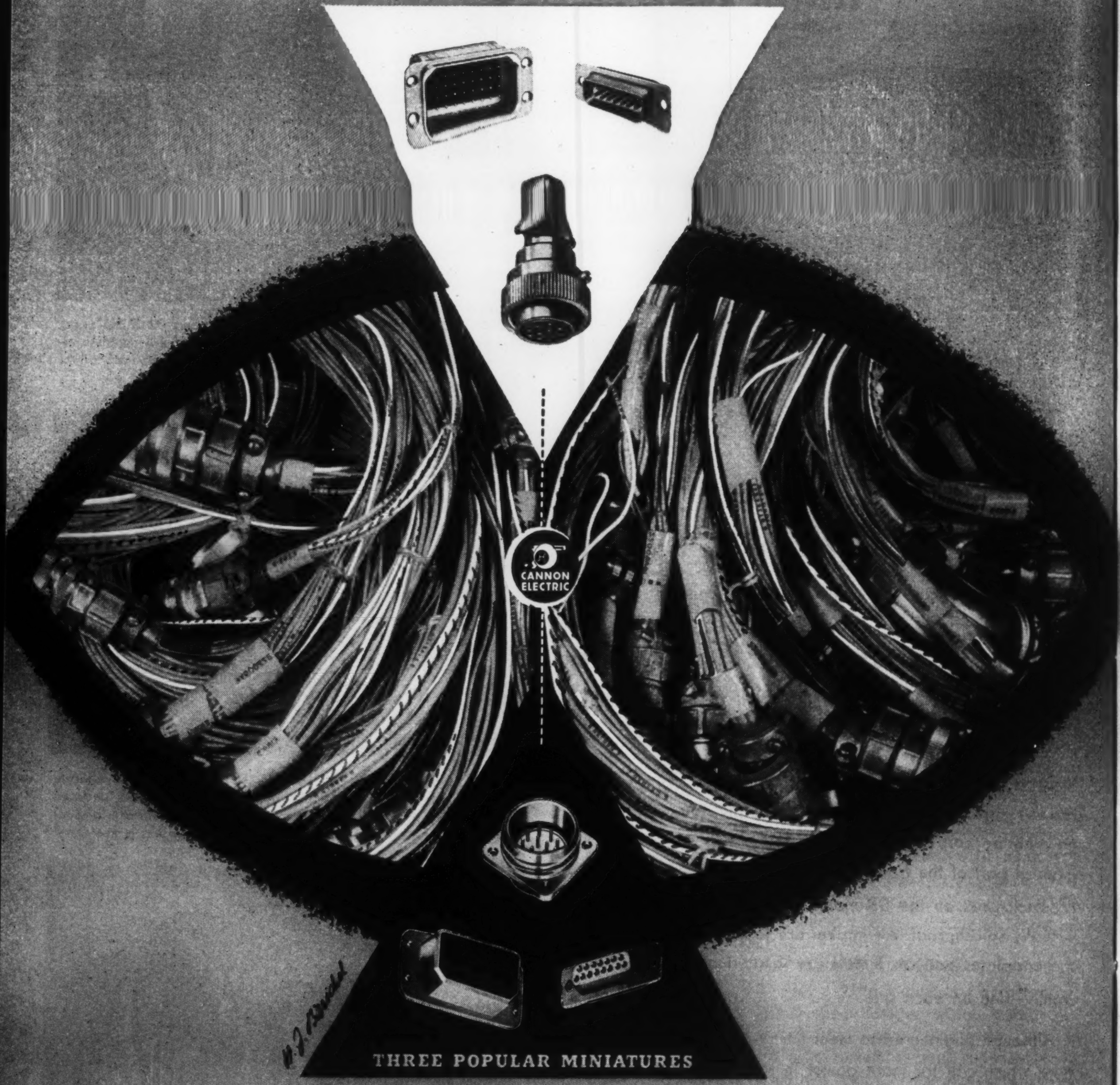
M56-4

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

—ITEM 618—
For More Information Circle Item Number on Yellow Card—page 19

Experience has shown that connector problems fall into three main classes —(1) Selection of the most suitable connector from those cataloged—(2) Modification of an existing type or the use of a non-cataloged "special"—or, (3) Design and use of a new type or series.

MINIATURES AND SUB-MINIATURES



connector problems?

The first problem may best be met by the use of Cannon Electric Condensed Catalogs (ICC and RJC) plus the Plug Guide (CPG) and the small 8-page Guide which are keys to the various engineering bulletins on such types as AN (MIL Specification), Miniature, Rack/Panel/Chassis, Audio, etc. If modifications are required, consult your local Cannon Representative who in conjunction with factory sales engineers, constantly is making adaptations to fit special needs. New designs are always being considered, designed, and developed by Cannon Electric. For those whose requirements are "off-trail," a *"Connector Requirements Sheet,"* fully filled in, will save time and effort in arriving at a suitable design. We will gladly send this sheet upon request, plus the new Miniature Bulletin, or the other bulletins.

Please refer to Dept. 105

CANNON PLUGS

CANNON ELECTRIC CO., 3209 HUMBOLDT ST., LOS ANGELES 31, CALIFORNIA

WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF ELECTRIC CONNECTORS FOR INDUSTRY

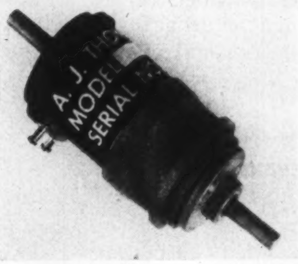
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Miniature Clutch-Brake

in standard and reverse actuation models

Electro - magnetic combination clutch and brake for electronic and instrument applications is small and light weight. Operating on dc input, the servo-mounted unit is available with output shaft at either or both ends. Controlled torque output under vibration meets requirements of MIL-E-5272A. Standard units deliver either brake or clutch torque when energized; reverse actuation units operate a brake when energized and are normally clutched when de-energized. Typical model MC-10 is 1.37 in. in diameter and 1.765 in. long. It weighs 7.5 oz and delivers 70 oz-in. combined clutch and brake torque. **A. J. Thompson Co.,** Route 1, Box 812, Florissant, Mo.

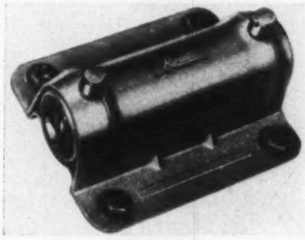


—Circle ITEM 461

Bearing Assembly

has self-aligning graphited or sintered bearings

Two sleeve bearings are mounted in a pressed-steel housing in this self-aligning Duplex bearing assembly. Horizontal-mounting assembly is supplied with either quality graphited or low-cost sintered bearings. For vertical-mounting or thrust applications, Duplex assembly includes graphited flanged bearings and a thrust collar. Vertical models are available for $\frac{3}{4}$ and 1-in. shafts; horizontal model comes in range of bore sizes from $\frac{1}{2}$ to 1 in. Housings measure $5\frac{1}{8}$ in. long, 4 in. wide and 2 in. high, with shaft-center height at 1 in. **Randall Graphite Bearings Inc.,** Greenlawn & Lake Ave., Lima, O.

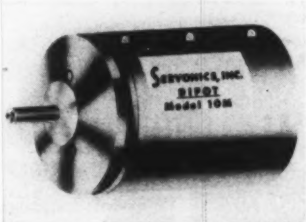


—Circle ITEM 462

Precision Potentiometer

has Kelvin-Varley voltage-divider circuit

Operating as an "automized" Kelvin-Varley circuit, this Dipot precision multiturn potentiometer subdivides voltages from matched resistors with a vernier potentiometer. Phase shift is reduced to a minimum by use of pie-wound resistors. Unit is available as five or ten-turn pot, with or without centertap. Special servo model is also available with 180-deg overtravel on each end to prevent overshoot or end sticking. Standard linearity in 10-turn model is 0.01 per cent; optional total resistance values can be furnished in standard ranges. **Servonics Inc.,** 834 N. Henry St., Alexandria, Va.

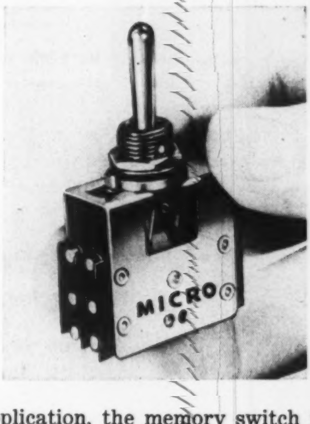


—Circle ITEM 463

Toggle Switch

has electrical memory that shows last momentary position

This toggle-switch assembly, designated 21AT1, incorporates three single-pole, double-throw functional switches and one single-pole double-throw "memory" switch. In application, the memory switch indicates by pilot light or buzzer which circuit was last actuated. The three functional switches operate at three lever positions—maintained-center, or momentary at each extreme lever position. Two functional switches actuate when the lever is moved to one extreme position; the other is actuated in the other extreme position. The memory switch is actuated (and maintained) in one extreme position and is released in the other extreme position. The lever returning to center does not affect the memory switch, which shows by



1936
20th ANNIVERSARY
DURAKOOL®
1956

20 years of

OUTSTANDING PERFORMANCE

Have made Durakool Tilt-Switches and Timer-Relays the Recognized Standard of Industry

Now celebrating its 20th year, Durakool, Inc., is proud of the many records of achievement set by its mercury tilt-switches and timer relays.
The basic "Sealed under pressurized hydrogen" principle has been proved on thousands of applications. So successful have they been that they are now the accepted standard of the industry:

- Millions of contacts or cycles without faltering
- Outlasts the normal equipment life
- Trouble free under every practical temperature or humidity condition.
- The tougher the assignment, the more Durakools stand out.

For detailed information about your exact application WRITE TODAY.

DURAKOOL, INC.
ELKHART, INDIANA, U. S. A. • 700 WESTON RD., TORONTO 9, CANADA

Durakool

VISIT OUR BOOTH NO. 520 AT THE DESIGN ENGINEERING SHOW
PHILADELPHIA, MAY 14-17

—ITEM 620—

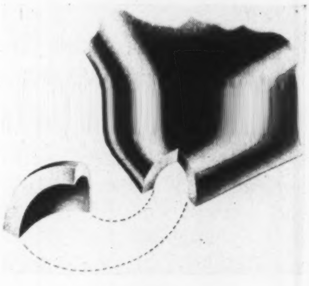
pilot light the most recent extreme momentary position of the lever. Switch rating is 5 amp, 125 or 250-v ac; dc rating at 30 v is 3 amp (inductive) at sea level. **Micro Switch,** Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

—Circle ITEM 464

Spherical Corners

improve appearance of welded panels and enclosures

Offered in metal thicknesses from 1/8 to 1/2-in., this line of prefabricated spherical corners provides smooth corner contours for welded machine bases, fixtures, housings and panels. Installation of corners requires that four corners of base panel be notched and edges bent to a standard radius. Corner radii available from 1 1/8 to 3 in., depending on metal thickness. **Conner Steel Products,** 24690 Telegraph Rd., Detroit 19, Mich.

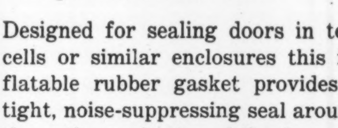


—Circle ITEM 465

Pneumatic Door Seal

stops noise and air leaks

Designed for sealing doors in test cells or similar enclosures this inflatable rubber gasket provides a tight, noise-suppressing seal around the entire perimeter of the door, including the corners. Section shown can be supplied to fit any size and



Dotted area shows gasket inflated

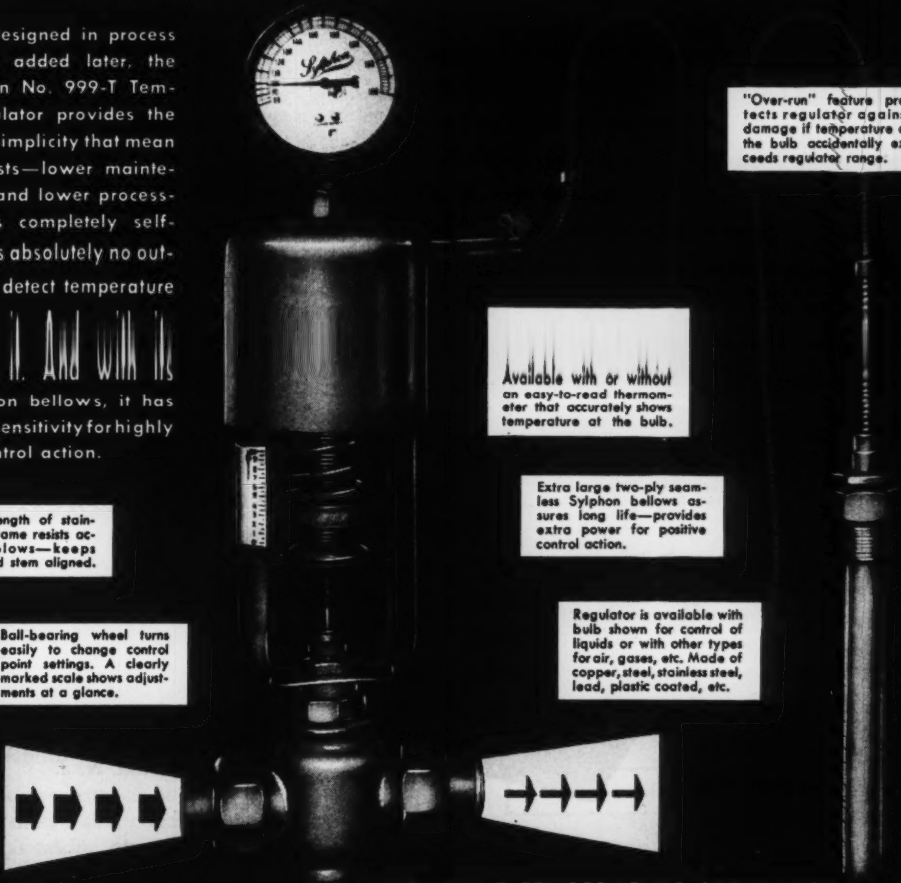
FULTON SYLPHON
TEMPERATURE
REGULATOR
HEADQUARTERS,
U.S.A.

CONTROLS TEMPERATURE

UNDER ITS OWN POWER

COMPLETE LINE OF REGULATORS, VALVES, MIXERS, AND CONTROLS FOR LIQUIDS, AIR OR GASES.

Whether it's designed in process equipment or added later, the Fulton Sylphon No. 999-T Temperature Regulator provides the accuracy and simplicity that mean lower first costs—lower maintenance costs—and lower processing costs. It's completely self-contained, uses absolutely no outside power to detect temperature or to control it. And with its famous Sylphon bellows, it has the power and sensitivity for highly responsive control action.



"Over-run" feature protects regulator against damage if temperature at the bulb accidentally exceeds regulator range.

Available with or without an easy-to-read thermometer that accurately shows temperature at the bulb.

Extra large two-ply seamless Sylphon bellows assures long life—provides extra power for positive control action.

Added strength of stainless steel frame resists accidental blows—keeps bellows and stem aligned.

Ball-bearing wheel turns easily to change control point settings. A clearly marked scale shows adjustments at a glance.

Regulator is available with bulb shown for control of liquids or with other types for air, gases, etc. Made of copper, steel, stainless steel, lead, plastic coated, etc.

NO. 999-T TEMPERATURE REGULATOR

Available with 60 F ranges between 20 and 455 F.
Variety of valve types in sizes from ¼" to 4".

Mr. Controls

Robertshaw-Fulton

CONTROLS COMPANY

FULTON SYLPHON DIVISION
Knoxville 1, Tenn.

Robertshaw-Fulton Controls Co.
FULTON SYLPHON DIVISION
Knoxville 1, Tenn.

☐ Send literature on Temperature Regulators for Industrial Processes, Catalog D-JF

Name________________________________

Company______________________________

Address______________________________

City________________ State____________

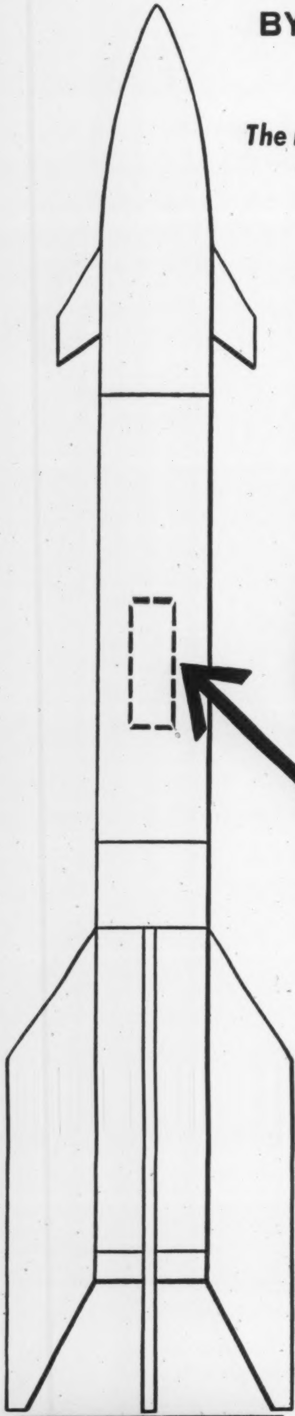
—ITEM 621—
For More Information Circle Item Number on Yellow Card—page 19

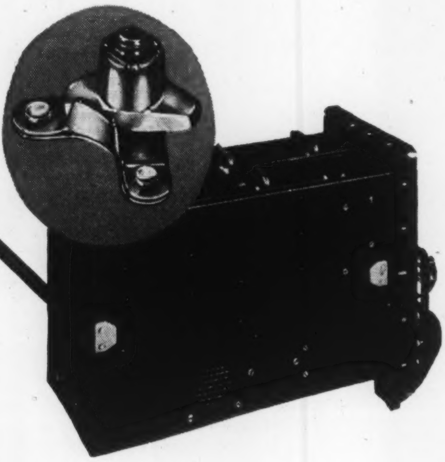
NEW PANELOC
ROTARY LATCH ADVANTAGES LISTED
BY BELL Aircraft
CORPORATION

The next 135 words of this advertisement taken from Bell Engineers' letters

S. W. Esmond, Product Engineer:

- Electronic equipment shown was designed to use the PANELOC Rotary Latch at a great saving in space and weight, so vital to the aircraft engineer.
- Rotary Latch assembles to door or panel itself—no stud-to-receptacle line-up problem.
- Tests show no sheet separation—fastener locks with the effect of a nut and bolt assembly.
- Vibration tests also had no effect on the Rotary Latch.





F. P. Bassett, Project Engineer:

- Rotary Latch selected for use on cowl access doors on Bell's latest vertical-rising (VTOL) aircraft.
- The new PANELOC Rotary Latch is excellent for hinged doors and applications where maximum access and opening are important design considerations.
- Its simplicity, vibration resistance, ease of installation and cost are other factors that resulted in Bell's adoption of this new fastener.
- Now in use on fixed-wing aircraft, helicopters, missiles, electronic components.

PANELOC

Write for catalog and price list for your file

A PRODUCT OF SCOVILL

Scovill Manufacturing Company, Aircraft Fastener Div.
50 Mill Street, Waterbury 20, Connecticut

—ITEM 622—

shape door, rectangular or circular. Working pressure of the gasket ranges from 25 to 40 psi; clearance required between door and jamb is ¼-in. The seal can also be applied to pressure or vacuum-chamber doors. **Continental Rubber Works**, 19840 Liberty St., Erie 6, Pa.

—Circle ITEM 466

Ceramoplastic

is copper clad for etched-circuit use

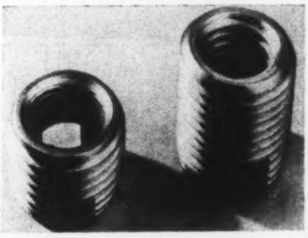
Copper-clad Supramica 500 machining grade ceramoplastic for use in the manufacture of etched circuits has age and dimensional stability under adverse conditions of storage or use. It is well suited for circuits in which small warpage might introduce variable contact resistance or changes in capacity or inductance. The material withstands temperatures to 450 F, its thermal endurance being limited only by the bonding agent used to apply the copper. Radiation-resistant, it provides circuit stability under extreme conditions and high dimensional accuracy. Etched circuits on the ceramoplastic can be furnished, or the material can be supplied machined to specification for further processing. **Mycalex Corp. of America**, Clifton Blvd., Clifton, N. J.

—Circle ITEM 467

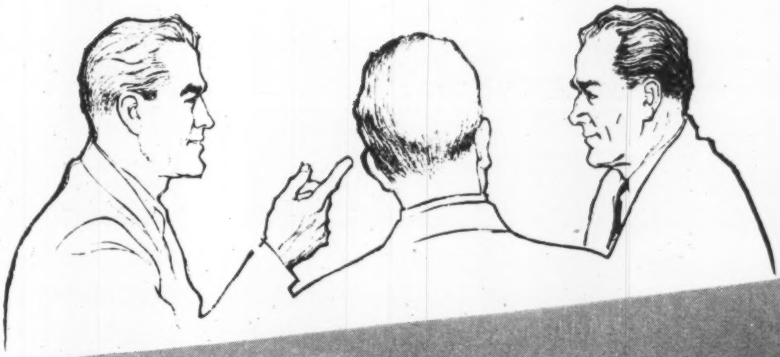
Inserts

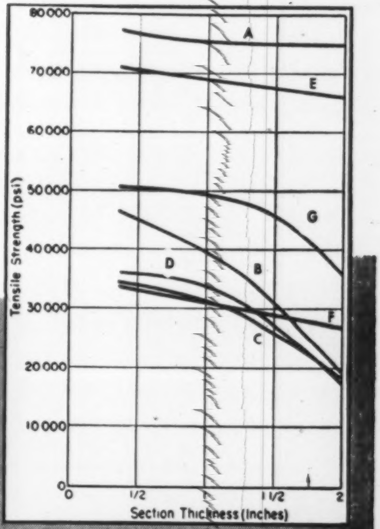
in short lengths for thin boss materials

Short series Tap-Lok insert (left) is designed for applications where



thickness of material prevents the use of the regular length insert (right). It is used where thread wear conditions exist due to repeated assembly and disassembly in comparatively soft materials such



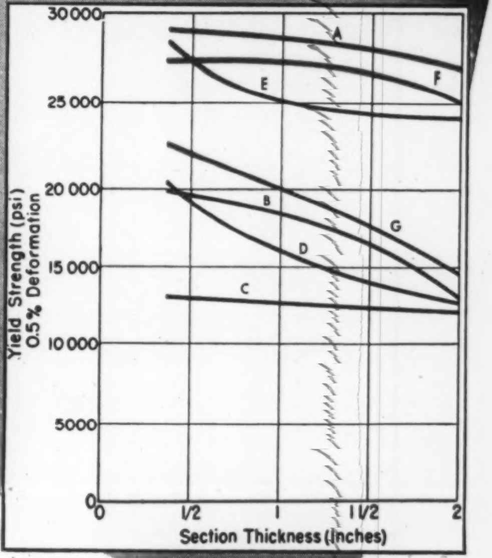


Tensile strengths of various non-ferrous metals vs. section thickness

Here's proof....

that you can use lighter sections, have greater strength, improve your product, save money

with AMPCO* Metal



Yield strengths of various non-ferrous metals vs. section thickness

Examine these charts carefully — they tell a story that can save you money and put extra life and dependability into your product.

Look, for instance, how other non-ferrous metals show a sharp decrease in mechanical values as casting cross-sections increase.

Ampco remains practically constant — you require less metal.

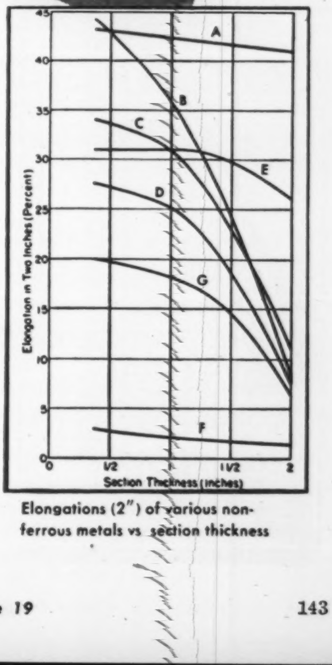
Note Ampco's unusually high tensile and yield strengths compared with conventional bronzes — you use lighter sections to do a better job. And Ampco Metal weighs 10 to 15 percent less than other bronzes — so you can make important weight reductions

Fact is, Ampco Metal's high strength-to-weight ratios can mean real savings for you — savings in material and money. Consult your nearby Ampco field engineer for full information or write us.

CHART REFERENCE

- **A. Ampco Metal**
- **B. Tin Bronze (88-8-4)**
- **C. Red Brass**
- **D. Tin Bronze (85-5-5-5)**
- **E. Manganese Bronze**
- **F. Aluminum Alloy**
- **G. Silicon Bronze**

Charts courtesy Materials & Methods and Westinghouse Electric Corp



Elongations (2") of various non-ferrous metals vs section thickness

AMPCO®

Sole Producer of Genuine Ampco Metal

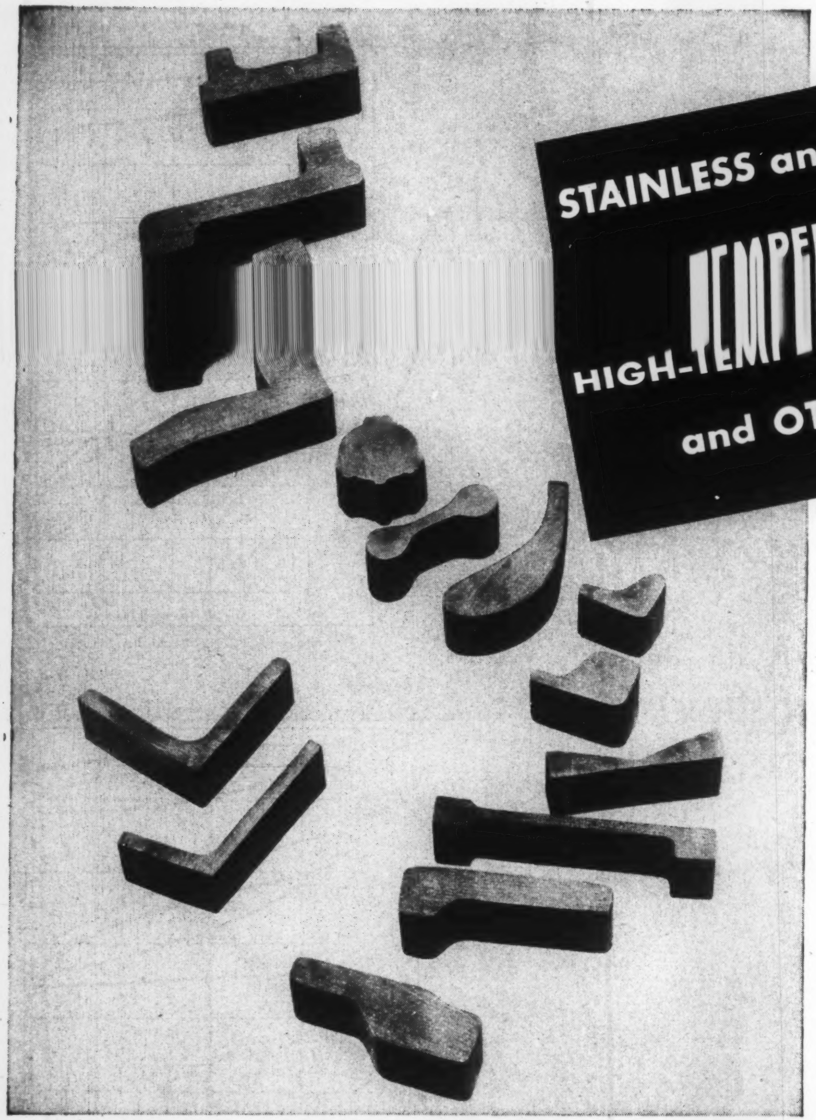
AMPCO METAL, INC.

Dept. MD-5, Milwaukee 46, Wisconsin
***West Coast Plant:* BURBANK, CALIFORNIA**

*Reg U S Pat Off

D-43

—ITEM 623—
For More Information Circle Item Number on Yellow Card—page 19



STAINLESS and TOOL STEELS
HIGH-TEMPERATURE ALLOYS
and OTHER STEELS

A-L HOT EXTRUSIONS (solid and hollow) may solve problems for you

Help! **(Dept. MD-77)**

We have a parts problem that hot extrusions might solve. Let's see an AL representative for facts and figures.

☐ STAINLESS STEEL
☐ TOOL STEEL
☐ HIGH TEMPERATURE STEEL
☐ OTHER STEELS

Name____________________
Company____________________
Address____________________

Where can these leading advantages of hot-extruded special alloy steels apply to your production?

1. Hot extrusions require very little finishing before use, even in the case of involved shapes. The scrap loss is small and you can buy raw materials closer to finish size. You buy less high-cost steel, cut away less of it . . . save both in time and material cost.

2. The range of shapes, solid or hollow, which can be hot-extruded is almost infinite. They can be easily and quickly produced in any quantity. Dies for new or experimental parts cost little and can be made up fast.

We're ready to serve your needs with hot extrusions in any grade of stainless or high temperature steel, many tool steel grades and other steels. Call us in to help. *Allegheny Ludlum Steel Corporation, Oliver Building., Pittsburgh 22, Pennsylvania.*

Leading Producer-High Alloy Steels

Allegheny Ludlum

AL
TIME-TESTED STAINLESS STEEL

W&D 5318

—ITEM 624—
For More Information Circle Item Number on Yellow Card—page 19

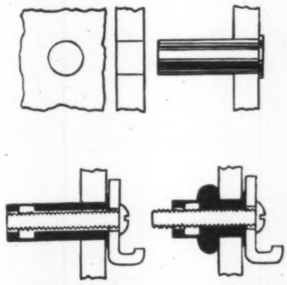
as aluminum, magnesium and plastics. The insert is also applicable to slightly harder alloy materials of magnesium and aluminum, permitting use of thinner bosses and wall thicknesses to decrease weight without penalizing tensile strength. The short series is available in hardened steel, stainless steel and brass. **Groov-Pin Corp.**, 1128 Hendricks Causeway, Ridgefield, N. J.

—Circle ITEM 468

Fastener

forms vibration-proof, watertight attachment

This Well-Nut fastener provides an airtight, watertight seal when used with panels too thin to be tapped for a screw. It consists of a tough rubber bushing with a threaded brass nut bonded in one end and a flange on the other. The fastener will not damage thin plastics, porcelain or glass and will not shake loose under extreme vibration. Assembly is made from one side only. Available diameters range from 5/16 to ½-in. with thread sizes 6-32, 10-32 and ½-20. **Rockwell Products Corp.**, 146 Central Ave., Newark, N. J.



—Circle ITEM 469

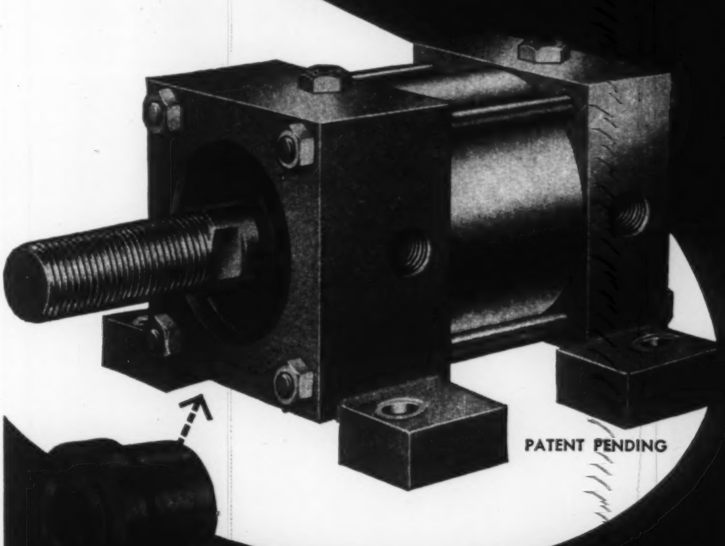
Weld Nut

can be positioned without jigs or fixtures

Rectangular shape of this RN weld nut adapts it for installation on

(*Continued on Page* 148)

*APPROVED HEAVY-DUTY AIR CYLINDERS *for* Automation



QUICK-CHANGE PACKING CARTRIDGE *Cuts Downtime*

Step up production with rugged, service-free, S-P Heavy-Duty Air Cylinders:

- Designed for 200 PSI
- Rolled steel end plates
- Extra long cushions
- Extra large, hardened piston rod
- Minimum mounting and envelope dimensions
- 5 types of mountings
- 8 bore sizes, 1½" to 6"
- Double porting
- Interchangeable check and cushion valves
- Quick-change packing and bearing cartridge

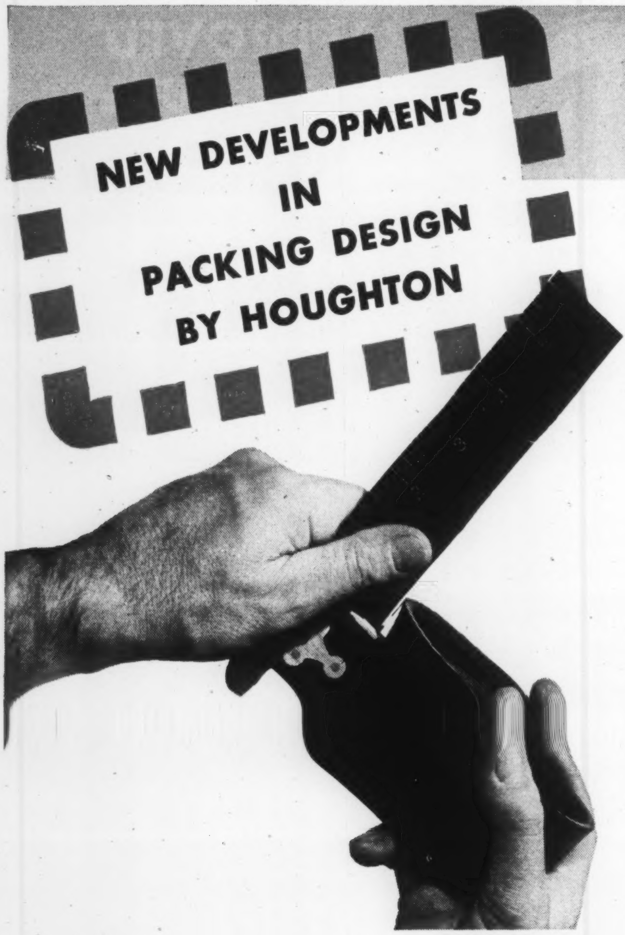
* S-P Automation Cylinders were designed expressly for a large automobile manufacturer. They are thoroughly proven for automation and general heavy-duty applications. Prompt deliveries. Send for Catalog 109. For S-P standard Air Cylinders, request Catalog 102. The S-P Manufacturing Corp., 12415 Euclid Ave., Cleveland 6, Ohio.

THE S-P MFG. CORP. — Cleveland
A Bassett Company
PRECISION PRODUCTS SINCE 1916

AIR AND HYDRAULIC CYLINDERS • POWER CHUCKS • ROTATING AIR CYLINDERS
COLLET AND DRILL PRESS CHUCKS • AIR PISTONS VALVES AND ACCESSORIES

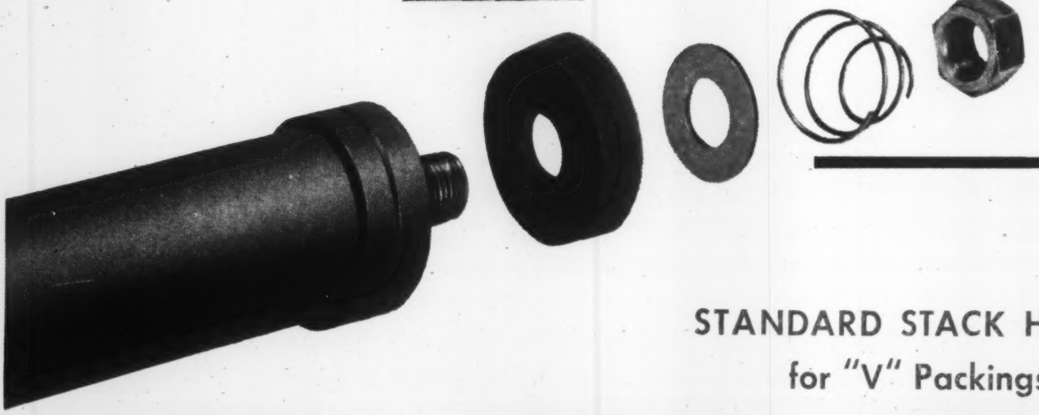
—ITEM 625—

For the most


NEW DEVELOPMENTS
IN
PACKING DESIGN
BY HOUGHTON

PRE-FORMED SHOULDER AND FLARE MAKE CUP PACKINGS SEAL BETTER

SPRING MOUNTED CUPS



STANDARD STACK HEIGHT for "V" Packings

HOMOGENEOUS RUBBER

FABRICATED RUBBER

LEATHER

advanced packing engineering

Call HOUGHTON

Houghton's newly designed leather cup packings are preformed. They *fit* the square corner normally found between the end of the piston and the cylinder wall.

As a result, there is no distortion of the packings under operating pressure. They are not forced into a *new* shape which would cause premature wear, fracture or breakdown at the heel. In addition, the sidewalls are molded with a slight flare which provides sufficient pre-loading for perfect sealing at minimum pressures.

Provide Better Seal...Reduce Friction...Increase Life

Houghton hydraulic research has come up with one of the chief answers to the problem of excessive friction, short cup life and chatter so often encountered in cup packing installations. Now, instead of the squeezing action of tightly bolting the cup packing in place between the piston and the follower plate, you can use a low pressure spring mounting which does not deform the cup and cause early failure.

Now we have standardized the stack height of *all* Houghton "V" packings. This means that they are interchangeable with each other in regard to stack height. Whether you use homogeneous rubber, fabricated rubber or leather "V's" . . . they'll fit! You can forget "special" dimensions, set up by various packing manufacturers for particular types of packings.

This leadership in hydraulic know-how is typical of Houghton, which makes all types of hydraulic and pneumatic packings, as well as a complete line of hydraulic oils and fire-resistant fluids.

Standardize on Houghton. You'll get the newest first—and the best always. Call your Houghton Man and let him explain Houghton's Hydraulic Service. E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.

VIX-SYN "O" RINGS

VIX-SYN O-RINGS

VIM #1243-3 CUP PACKINGS

VIM 1243-3 LEATHER CUP PACKINGS

VIX-SYN "V" PACKINGS

VIX-SYN "V" PACKINGS

VIM "V" PACKINGS

VIM LEATHER "V" PACKINGS

VIX-SYN "U" CUP PACKINGS

VIX-SYN "U" CUP PACKINGS

VIM "U" PACKINGS

VIM LEATHER "U" PACKINGS

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service...

—ITEM 626—

PROVIDES THE *PUSH*
BEHIND THE PUSH BUTTONS

Photos courtesy Herring-Hall-Marvin Safe Company, Hamilton, Ohio

TUTHILL MODEL OOL

Powers Electro-Hydraulic Control

On Automatic Vault Doors

In step with today's automatic age, this unique bank vault door operates by push-button control. To power the electro-hydraulic mechanism that controls this automatic opening and closing operation as well as lowering and raising the foot bridge, H-H-M engineers selected the Tuthill Model OOL, known the world over for its dependable performance.

The dependability so essential for applications like this is engineered into the Tuthill Model OOL. Vertical ports maintain its prime. The mechanical seal contributes to quiet, leak-free performance and low power consumption. Precision manufacture assures constant delivery of capacity required. And as a final guarantee of performance, every Tuthill unit is subjected to the most exhaustive tests before shipment—to make them extra safe for safe service.

TUTHILL
PUMP COMPANY
Dependable Rotary Pumps
. . . since 1927

939 East 95th Street
Chicago 19, Illinois

Write today for complete data on Tuthill pumps for hydraulic service.

See our catalog in Sweet's Product Design File 6b-Tu

Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd.
Ingersoll, Ontario, Canada

—ITEM 627—

(*Continued from Page* 145)

parts with narrow flanges or channels as well as on tubular, flat, or beveled pieces. Precision pilot on the nut locates it to close tolerances, eliminating the need for welding jigs or fixtures. Dual-line projections provide added strength where welds are subjected to tension loads. Thread sizes available range from 6-32 to 3/8-16. **Ohio Nut & Bolt Co.,** 33 First Ave., Berea, O.
—Circle ITEM 470

Plastic Laminate

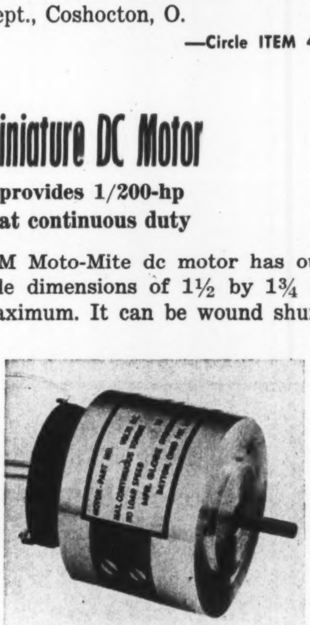
for printed-circuit panels

Textolite Cold Punch 11570 is an insulating XXXP phenolic paper-base laminate which permits close registration punching at normal room temperatures. Printed circuits can be precision-punched, facilitating the use of automatic assembly equipment in mounting components. Translucency of the laminate permits a visual check for accuracy of circuit registration. Other properties include high flexural strength, low power factor, high heat resistance and optimum uniformity. **General Electric Co.,** Laminated and Insulating Products Dept., Coshocton, O.
—Circle ITEM 471

Miniature DC Motor

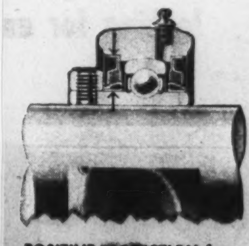
provides 1/200-hp at continuous duty

WM Moto-Mite dc motor has outside dimensions of 1½ by 1¾ in. maximum. It can be wound shunt,

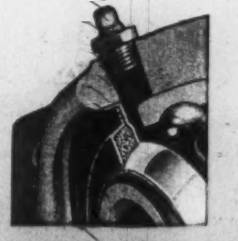


series or split series. Series and split series motors can be wound for 115 v dc operation; shunt motor can be wound for 70 v dc. Armature windings are available for a variety of speed and torque characteristics, and either spur or

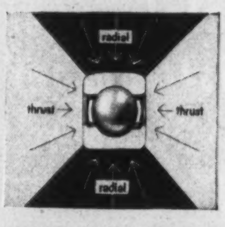
MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings



POSITIVE PROTECTION from moisture, dust and dirt is provided by self-aligning seals extending from housing to inner ring. Aligning surfaces are enclosed and lubricated, assuring free alignment.



AUTOMATIC RELIEF OF EXCESS GREASE PRESSURE is provided through lubrication fitting and patented seal arrangement. Extra large grease capacity extends lubrication intervals.



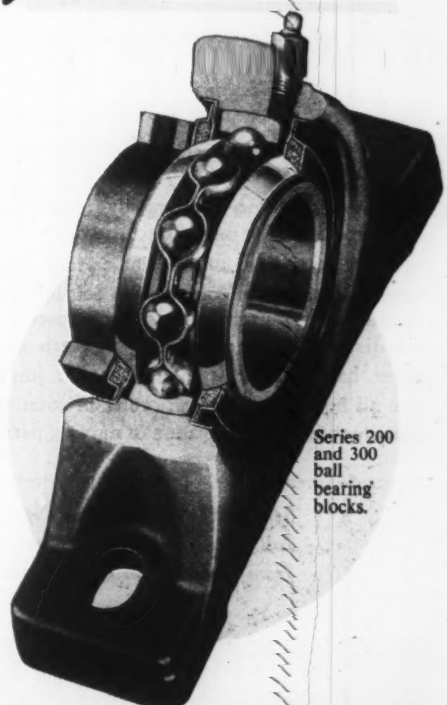
HIGHEST CAPACITY available to carry radial, thrust or combination radial-thrust loads is provided by single-row, deep-groove design.

RUGGED HOUSINGS result from superior foundry practices. Base is cored to assure stress-free, maximum-strength casting.

◀ **DIRTY CONDITIONS** around this portable asphalt mixer manufactured by K. E. McConnaughay Co., Lafayette, Ind., make Link-Belt ball bearings the logical choice.

grease stays in, dirt out

thanks to the effective sealing of Link-Belt ball bearings



Series 200 and 300 ball bearing blocks.

HERE'S an important extra only Link-Belt gives you on ball bearing blocks! *It's an exclusive seal arrangement*—all aligning surfaces as well as rolling elements are fully lubricated and sealed, assuring long, maintenance-free performance.

All seals are self-aligning—extra assurance that grease stays in, dirt stays out, regardless of alignment. The single-row bearing, too, is self-aligning—in all directions. Free rolling and full load capacity are maintained despite shaft deflection or misalignment.

Both Link-Belt ball and roller bearings offer the "fully-protected" sealing feature. Choose from industry's most complete line of pillow blocks, flange, flange cartridge, cartridge, takeup and hanger blocks. Ask any one of the 40 Link-Belt offices for Data Book 2550.

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,989-A

—ITEM 629—

Don't go daffy

looking for universal joints

asg

UNIVERSAL JOINTS

immediately available from distributors stock

13

sizes with

bored or solid hubs

You can get ASG Universal Joints directly from stock in 13 sizes with bored or solid hubs ranging in diameter from .375" to 4.000". Special bores, bores with keyways or setscrews are available upon special order.

ASG Universal Joints are ruggedly constructed of heat treated alloy steel. Matching or mating parts are precision ground to permit easy interchangeability of components. Self-locking retaining rings on small pins simplify assembly and disassembly. Joint of 7/8" length and longer have snap ball oilers. Smaller joints have oil holes. Oil enters at center of rotation to assure thorough lubrication of moving parts.

Send today for Bulletin No. 527 describing the full line of A.S.G. Universal Joints available from your nearest distributor.

AMERICAN STOCK GEAR DIVISION

PERFECTION GEAR COMPANY • HARVEY, ILL., U.S.A.

—ITEM 630—

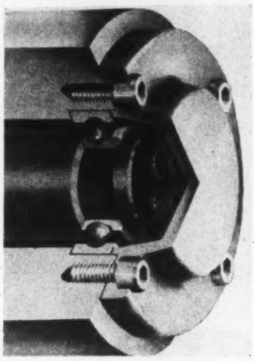
For More Information Circle Item Number on Yellow Card—page 19

planetary gear trains may be used as gear reduction. A governor can be provided for speed regulation. Wide range of speed control is attained by using a voltage divider. Motor meets rigid military requirements, has rugged, light weight construction and high torque to inertia ratio. The motor can be enclosed for all environmental requirements, including radio noise shielding, and provides up to 1/200-hp at continuous duty and 1/75-hp intermittent duty. **Globe Industries Inc.,** 1784 Stanley Ave., Dayton 4, Ohio.

—Circle ITEM 472

Bearing Housing Caps

in 400 styles and sizes



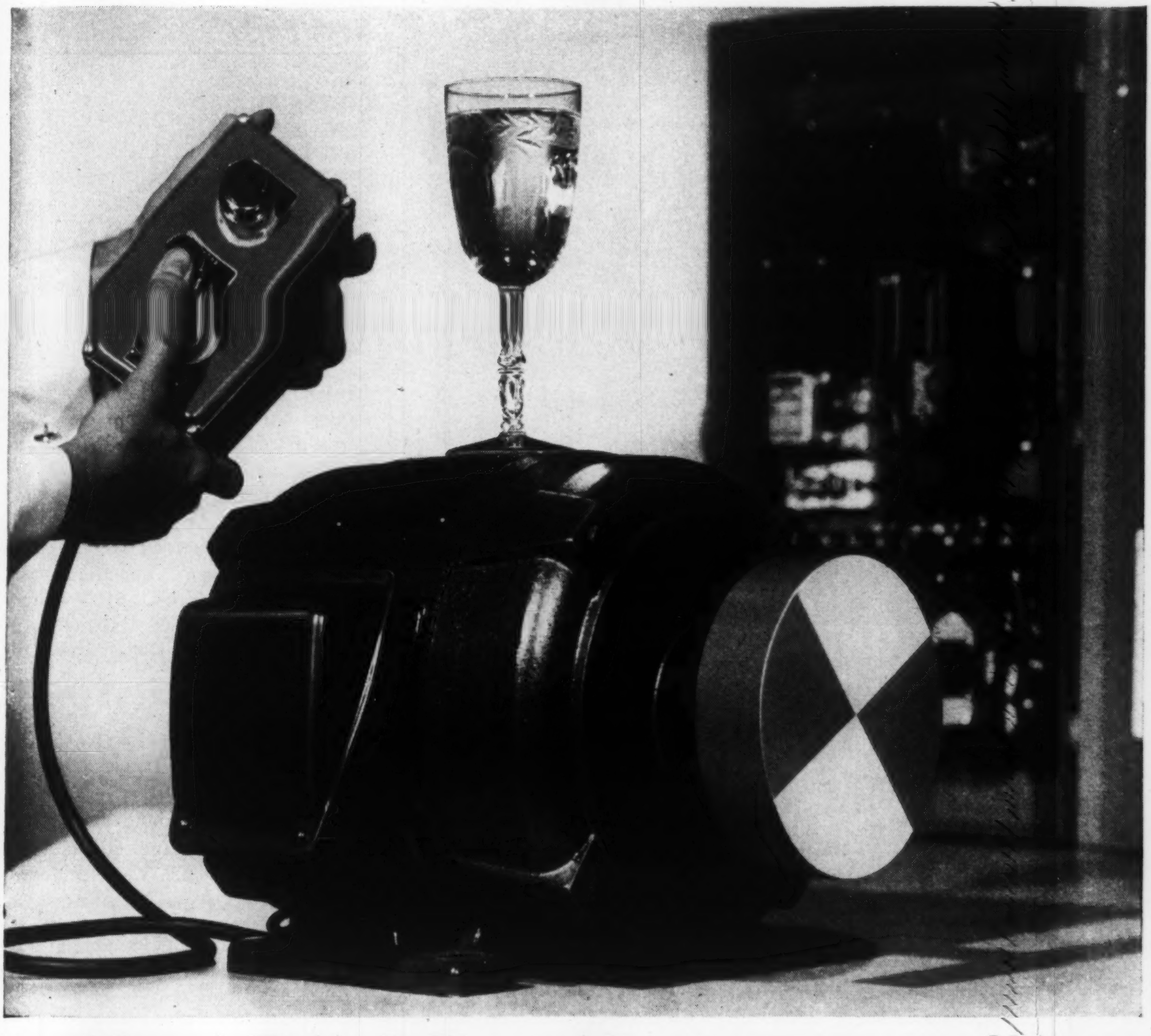
Cast-iron machine-finished housing caps meet most application requirements of regular, snap-ring, sealed and shielded ball bearings as well as roller bearings. They are available in 400 styles and sizes, including shallow and deep closed caps, open units, caps accommodating standard spring-loaded seals for various shaft extension diameters, and units furnished with felt seals. **Design Aids Co.,** 130 N. Seventh St., Newark 7, N. J.

—Circle ITEM 473

Trimming Potentiometer

has 98 per cent usable range

Subminiature Trimpot Model 130 is equipped with solder-lug terminals to permit wiring direct to the unit, using simple soldering or dip-soldering techniques. Terminals are durable and can be bent at right angles to the body for easy installation. The instrument has a



New DynAC® stops motors *instantly*...without a ripple!

Here's dramatic proof of the smooth, controlled braking action of the new Westinghouse DYNAC braking controller. Motor stopped *instantly*—without disturbing the water in the glass goblet. "Grabbing" or jerky stops are eliminated with DYNAC braking.

Wherever rapid and/or controlled stopping is required, DYNAC can not only contribute an important safety factor, but it can save you headaches—*and money*—on: (1) production time, (2) material rejects and spoilage, and (3) maintenance expense.

Because it's *completely* electrical, DYNAC requires no mechanical apparatus or motor linkage—it simplifies maintenance. And it comes in *one* compact, spacesaving enclosure. Get the facts on DYNAC's many cost-cutting applications—with every type of standard induction motor. Use the coupon below for more information on DYNAC.

J-30200

YOU CAN BE SURE...IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION
P.O. Box 868, Pittsburgh 30, Pa.

Please send me descriptive bulletins 15-600 and B-6572 on the new DYNAC braking controller.

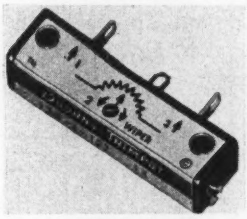
Name______________________________

Company______________________________

Address______________________________

City____________________ State__________

—ITEM 631—
For More Information Circle Item Number on Yellow Card—page 19



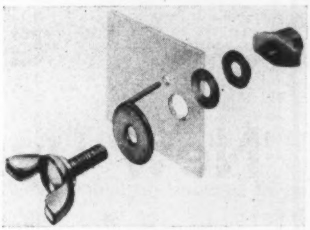
98 per cent usable potentiometer range, and is adjustable over 25 turns of the lead screw. Available in 11 standard resistances from 10 to 20,000 ohms, in resolutions from 2.0 to 0.02 per cent, the potentiometer meets or exceeds most applicable government specifications. **Bourns Laboratories,** 6135 Magnolia Ave., Riverside, Calif.

—Circle ITEM 474

Adjustable Latch

for use in materials to 0.150-in. thickness

Available in both round and wing-head types, this panel fastener is well suited for use on electronic equipment and instruments, and on closures requiring quick access. It can be used in materials up to 0.150-in. thick. Operating with a quarter turn, the latch requires no striker plate. Additional torque, applied after the fastener is engaged, pulls up the door to form a seal and eliminate vibration. Nylon pawl offers long life and smooth operation. Weight is 1/4-oz for the round head and 1/3-oz for the wing-head style. Latch is available in No. 8 and 10 screw sizes. **South Chester Corp.,** Southco Div., 200 Industrial Highway, Lester, Pa.



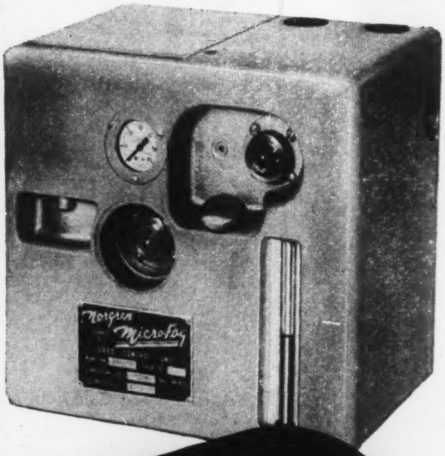
—Circle ITEM 475

Laminated Plastic

resists high temperatures

G-7-2 glass silicone laminated plastic shows high hot strength and good color fidelity, low water ab-

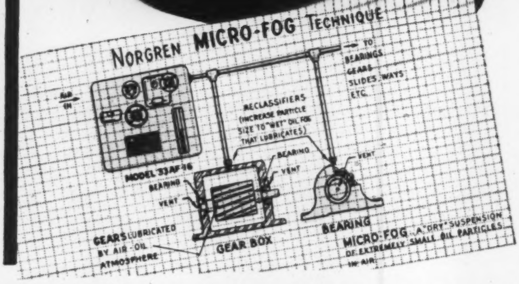
Norgren
MICRO-FOG
Model 33AF-16
Lubro-Control Unit



Easy to design into your machines—one lubricator does the job of many—provides controls to actuate an alarm system.

THE LATEST ADVANCEMENT IN CENTRALIZED LUBRICATION
. . . for up to 1000 bearing inches*

for
BEARINGS
GEARS
CHAINS
CAMS
SLIDES
WAYS
Other Machine Components


NORGREN MICRO-FOG TECHNIQUE
AIR IN
MODEL 33AF-16
TO BEARINGS GEARS SLIDES WAYS ETC.
RECLASSIFIERS (INCREASE PARTICLE SIZE TO "WET" OIL FOG THAT LUBRICATES)
BEARING
VENT
BEARING
VENT
VENT
GEARS LUBRICATED BY AIR-OIL ATMOSPHERE
GEAR BOX
BEARING
MICRO-FOG A "DRY" SUSPENSION OF EXTREMELY SMALL OIL PARTICLES IN AIR

AUTOMATIC MICRO-FOG LUBRICATION—The 33AF-16 Unit automatically creates a finely divided air-borne oil fog which can be uniformly distributed through complex piping systems to multiple lubrication points.

LARGE LUBRICATING CAPACITY—A single unit can completely lubricate even the largest machines — up to 1000 bearing inches.

AUTOMATIC ALARM CONTROLS—Two pressure switches and a float-controlled switch are provided to automatically actuate an alarm system or controls when air pressure fails, when excessive pressure develops in the oil reservoir, or when the oil supply needs replenishing.

COMPACT, COMPLETE UNIT—Although only 12" x 11" x 9" in size, this lubricator contains all necessary controls plus a 2-gallon oil reservoir—enough oil for 12 hours lubrication at maximum MICRO-FOG output.

AUTOMATIC DRAIN FILTER—Protects entire equipment from abrasive and corrosive air line contaminants. Drains collected liquids automatically.

PRESSURE REGULATOR—Accurately regulates air pressure for most efficient lubrication.

VISUAL OIL FEED—Oil feed dome on front of unit provides a quick visual indication of proper operation of lubricator.

TWO AIR SUPPLY INLETS—Both are 1/2". One is at left side, one in back of unit. The most convenient inlet can be used, the other plugged.

FOUR MICRO-FOG OUTLETS—Three outlets are 1 1/4", one is 2" with a female tapered thread. One or more may be used.

AUXILIARY AIR TAKE-OFF—A 1/8" take-off is provided in top of unit to supply air for pressure jet reclassifiers if required.

SOLENOID VALVE—Coordinates operation of the lubricator with starting and stopping of machine.

TWO ELECTRICAL INLETS—For 3/4" conduit — conveniently located at left end and at back of unit lead to splash-proof terminal compartment. Either or both may be used.

C. A. Norgren Co.
3442 So. Elati St., Englewood, Colo.

*For complete data on Norgren MICRO-FOG 33AF-16 Lubro-Control Unit, call your nearby Norgren Representative listed in your telephone directory—or WRITE THE FACTORY FOR BULLETIN 531.

Wherever Air is Used in Industry

IP

—ITEM 632—

WHEN YOU NEED A BEARING—*remember this:*

TORRINGTON ***makes every basic type of anti-friction bearing***

When there isn't a bearing big enough or small enough to do the job you want...

TORRINGTON will build it for you to the size and tolerances you need.

When you have a special problem...

A TORRINGTON ENGINEER will consult with you and recommend a bearing that's best for the job. You can rely on his judgment because bearings are his business and he has the backing of engineering staffs at Torrington, Conn., and South Bend, Ind.

We're proud we can offer our customers a service of such breadth and depth.

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TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

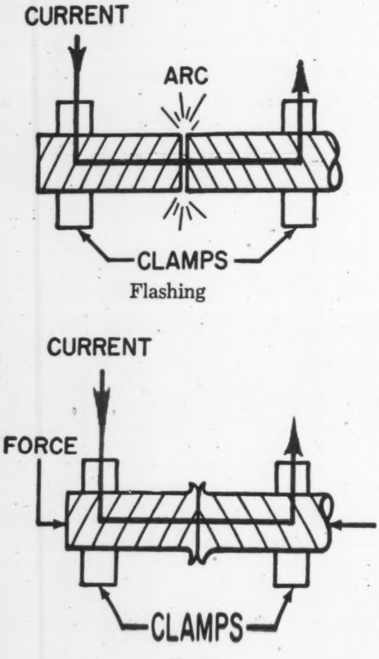
(Advertisement)

Flash-Butt Welding

How to Use It to Improve Product Design and Quality

What is Flash-butt Welding?

Flash-butt welding is a resistance welding process for end to end joining of rods, tubes, bars, forgings, fittings, etc., to achieve the greatest possible strength. It is accomplished by positioning the pieces to be joined with clamping electrodes so that there is initially light contact between abutting edges (Fig. 1).



Flashing

Upset

Fig. 1. Flash-butt welding process.

Introduction of the current causes flashing which generates great heat. As the metal is burned away the pieces are moved together in an accelerating motion. Thus, uniform flashing action is maintained for the most efficient heating process. When the inner faces obtain the proper temperature, they are forced together under high pressure and the current is cut off. The impurities (oxides, slag, etc.) formed during flashing are forced out in the upset action leaving pure base metal to form a high strength bond (Fig. 3).

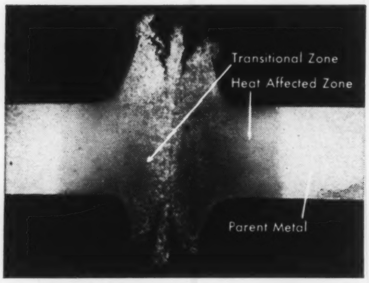


Fig. 2. Macrograph of 2" O.D. x .095" wall of 4140 alloy steel tubing flash-butt welded on a Sciaky Type BMW. 3-400 machine.

Advantages of Flash-butt Welding

Flash-butt welding offers a 100% strength factor compared to 80% strength factor for flame and arc welds. Further, no extra material such as gas, rod, or flux is required. *The material itself forms the weld.*

Flash-butt welding has low power demand and power consumption. Higher production speeds are more readily achieved with this process than with any other fastening method. The localized heat minimizes part distortion. Generally, no special preparation of the weld surfaces is required.

Simplicity and effectiveness of the Sciaky Flash-butt weld technique reduces multi-step fastening operations to just one. One operator (not skilled) can consistently produce high quality welds.

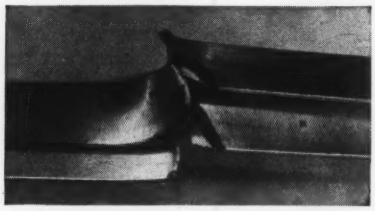


Fig. 3. Destruction test on extruded aluminum miter joint. Note that failure is in parent metal, not in the weld.

Dissimilar metals with widely varying melting temperatures are easily flash-butt welded.

When to Design for Flash-butt Welding

Whenever ideal flash-butt welds are required, the size and shape of the parts to be welded should be identical. However, a maximum of 15% variation in end dimension is usually permissible for commercial usage. New applications for this process are opening up every day. Often little, or no change in existing design allows conversion to high production flash-butt welding.

New Research Center for Your Design Problems

Sciaky's new three-quarter million dollar Research Center is equipped with the most advanced resistance welding machines, testing instruments, and trained personnel. The entire facility is devoted to solving *your* joining problems and advancing the application and development of resistance welding. The Research Center invites *you* to submit your fastening design problems.

Build Your Data File with Free Sciaky Literature

Write today on your company letterhead describing your particular field of interest. We will send suitable back issues (as well as future issues) of our "Resistance Welding At Work" publication, showing typical design problems solved by this method of fastening. All contain impressive case history examples of Sciaky basic thinking—resistance welding techniques designed to do more *useful work* at *lower operating costs* with *maximum reliability.*

Largest Manufacturers
of Resistance Welding Machines in the World

SCIAKY

Sciaky Bros., Inc., 4939 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

—ITEM 634—

For More Information Circle Item Number on Yellow Card—page 19

sorption, low wet power factor and high dielectric strength. Heat does not noticeably affect its mechanical and electrical properties. Useful in electrical and electronic applications, the laminate is available in sheets up to 36 x 72 x 2 in. **Formica Co.**, 4614 Spring Grove Ave., Cincinnati 32, O.

—Circle ITEM 476

Multi-Element Relay

has mercury-wetted contacts

Loads ranging from the microwatt level to ¼-kw can be switched by this multi-element relay. Contact resistances of less than 40 milliohms are obtained by use of mercury-wetted points; resistance remains constant within 1 milliohm over the life of the relay, estimated to be 1 billion cycles. Switch contacts in 2, 3 and 4-pole models are hermetically sealed and hydrogen pressurized in glass envelopes. Contact rating is 5 amps or 500 v. Maximum operating rate is 60 cps and speed is 5 millisec; faster operating speeds can be obtained through suitable circuitry. Octal-style plug bases or solder terminals can be furnished. **C. P. Clare & Co.**, 3101 Pratt Blvd., Chicago 45, Ill.

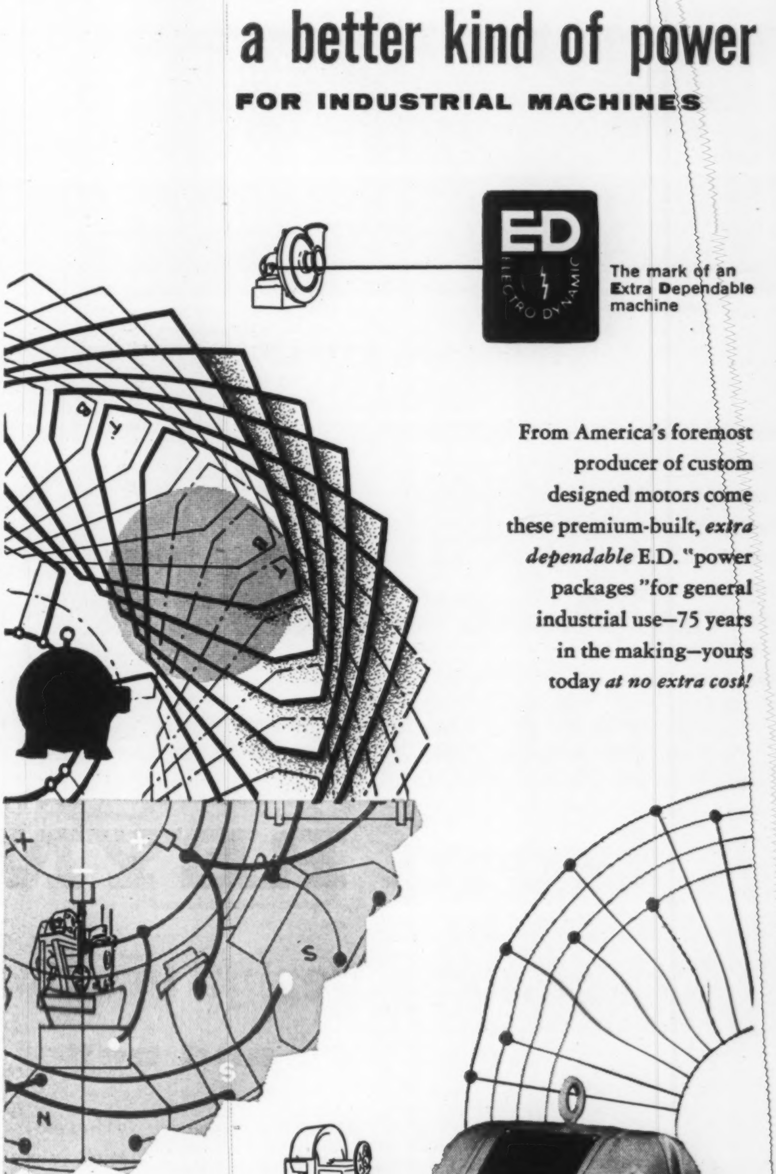
—Circle ITEM 477

Way Protector

has metal-supported neoprene convolutions

Designed to protect machine tool ways, such as in grinders, millers and boring machines, from chips and dirt, this neoprene-base way

(*Continued on Page* 158)



a better kind of power

FOR INDUSTRIAL MACHINES

The mark of an **E**xtra **D**ependable machine

From America's foremost producer of custom designed motors come these premium-built, *extra dependable* E.D. "power packages" for general industrial use—75 years in the making—yours today *at no extra cost!*

1 to 250 hp. AC and DC. N.E.M.A. standards.

ELECTRO Extra **DYNAMIC** Dependable motors

GD

PRODUCT OF GENERAL DYNAMICS

NEW...

Write for Brochure 100 and literature on new E.D. motors and drives.

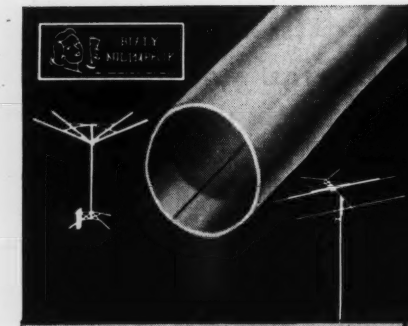
Electro Dynamic division of General Dynamics Corporation Bayonne, New Jersey

E.D. "Selectrol" Variable Speed Drives

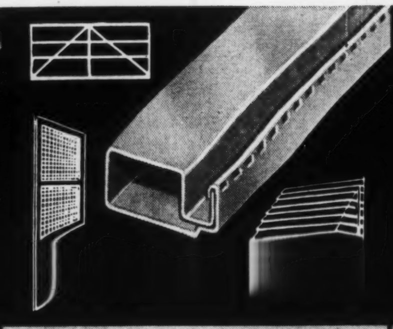
New Re-rated E.D. Motors

Gear-ED-motors

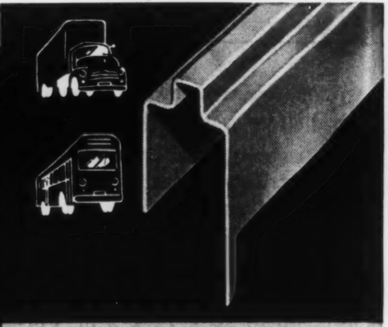
—ITEM 635—



High strength and superior finish of aluminum roll formed tubing pays off in sign frames of all sizes, TV antenna, clothes dryers and many other products.



Parts for window screens, farm gates, car ports, awnings and other building products are economically produced with aluminum roll formed shapes.



Many complex truck and trailer framing members, bus strips and other parts are easily fabricated with aluminum roll formed shapes.

Specify ALUMINUM Roll Formed Shapes from REYNOLDS

for economy, design freedom, dimensional accuracy and better finishes

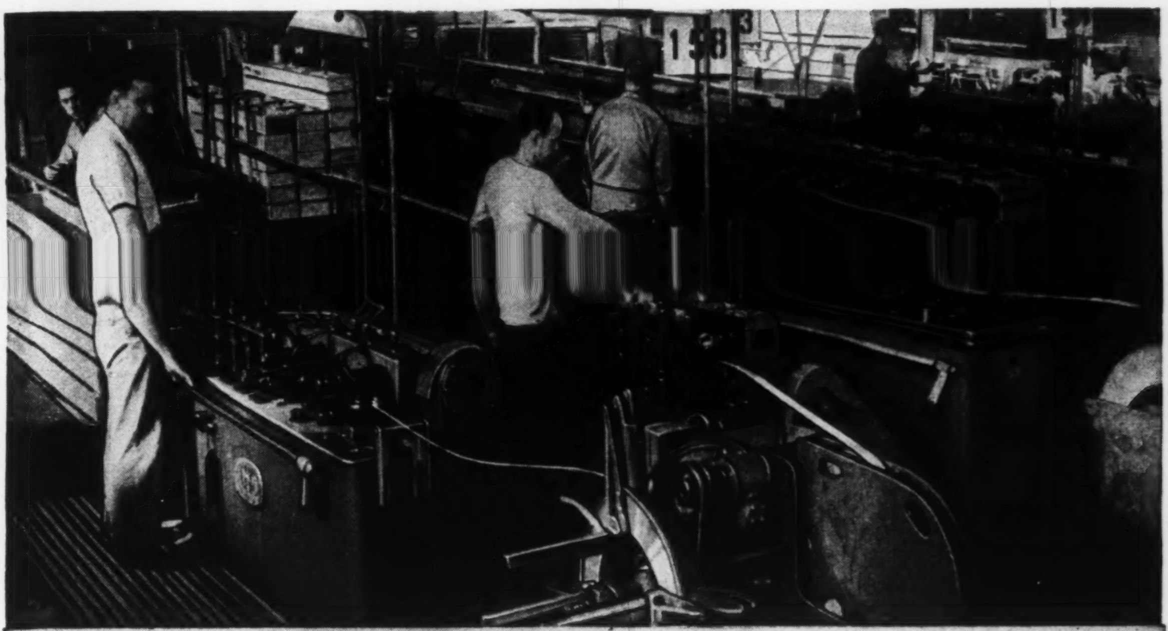
Rolling from coil stock permits savings that are impossible when working from flat sheet. Therefore, if you are fabricating a complex shape from flat sheet, or if you require a shape in long lengths, it will pay to switch to aluminum roll formed shapes from Reynolds.

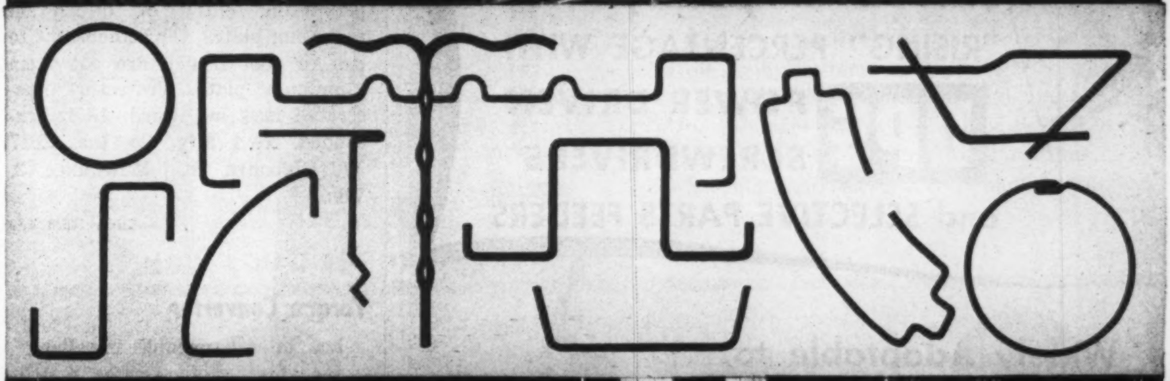
Reynolds roll forming can produce a wide range of easily fabricated shapes that aid in design flexibility. Closer tolerances on Reynolds roll formed shapes mean dimensional accuracy; better as-fabricated finishes often mean a more attractive product without additional finishing operations.

However, if an unusually high quality finish is important to the sales appeal of your aluminum product, Reynolds is your best source for clear anodized, color anodized or chemically brightened finishes on roll formed shapes. Reynolds new expanded finishing facilities go hand in hand with Reynolds sizable investment in roll forming machines and tooling.

For details contact your nearest Reynolds Office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2061 South Ninth Street, Louisville 1, Ky.*

REYNOLDS ALUMINUM FABRICATING SERVICE





The Finest Products

Made with Aluminum

are made with

REYNOLDS ALUMINUM

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Write for your free copy of 8-page brochure, "Aluminum Roll Formed Shapes by Reynolds".

See "FRONTIER", Reynolds exciting dramatic series, Sundays, NBC-TV

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING

FORMING • ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

—ITEM 636—

For More Information Circle Item Number on Yellow Card—page 19

Is your production barometer up?

CHANGE TO DPS
HAND METHOD BOTTLE NECKS
RISING
RISING PRODUCTION

You Get a

"RISING" PERCENTAGE WITH DPS POWER DRIVEN SCREWDRIVERS and SELECTIVE PARTS FEEDERS

Widely Adaptable to Individual Requirements

- Are you using DPS Power Equipment? If not, we urge that you get full details now . . . If you have a difficult problem, don't hesitate . . . Thirty years of experience with thousands of different applications . . . will enable us to cope with it and supply you with machines engineered to fit your needs. Progress demands DPS methods . . . Necessities in modern production where speed, economy and handling at minimum cost are so important . . . We can help you . . . Write today . . . Ask for catalog.

5 SCREWDRIVING MACHINES, Bench and Pedestal types. Model A pictured.

BOWL FEEDER, Vibratory type, to select and feed smaller, fragile parts.

BARREL FEEDER with stationary ring cover, for heavy-duty, large production runs.

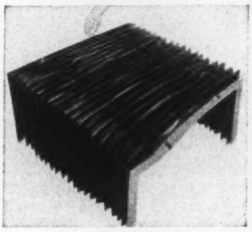
BARREL FEEDER conventional type, for parts requiring critical selection.

DETROIT POWER SCREWDRIVER CO.

2801-A W. FORT ST. DETROIT 16, MICHIGAN.

New Parts

(Continued from Page 155)



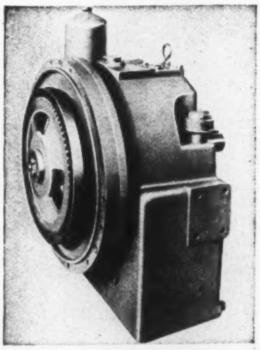
protector has its convolutions individually supported by metal bridges. Brass reinforcing grommets, integral with the convolutions, maintain freedom of the way-protector travel on top-supporting guide rods. Bottom of the protector extends over the edge of the bed, preventing entry of dirt. End mounting plates, for attachment to bed or tool frame, are cut from aluminum plate. Protector illustrated is 4 in. closed, 18 in. extended. **A&A Mfg. Co. Inc.**, 2017 W. Clybourn St., Milwaukee 3, Wis.

—Circle ITEM 478

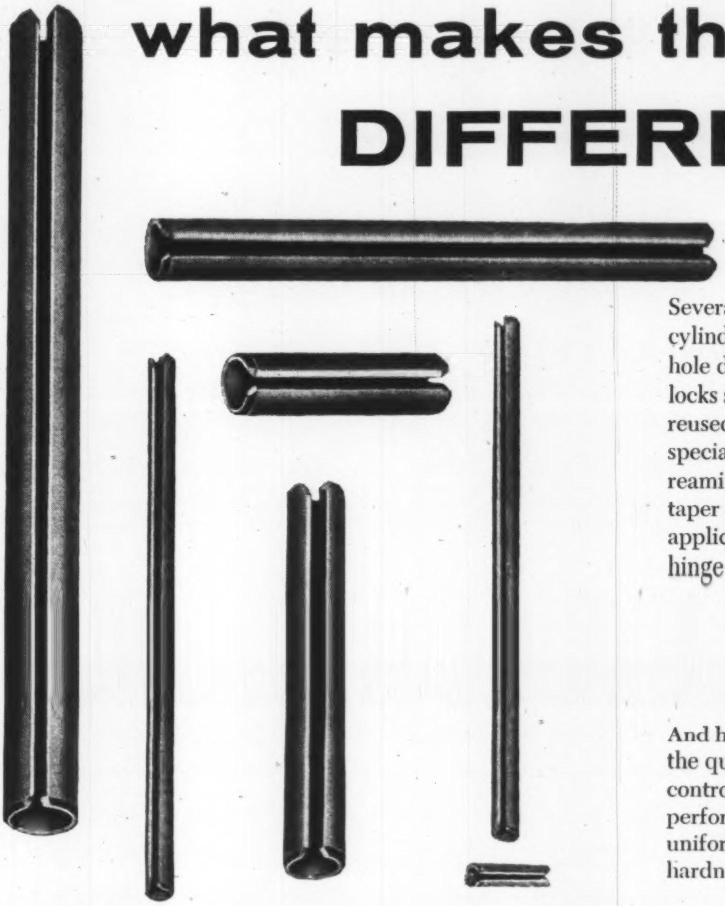
Torque Converter

has interchangeable impeller for close engine-torque match

New 1500 series single-stage torque-converter line is designed for engines rated from 30 hp at 1150 rpm to 198 hp at 2400 rpm. Torque ratings range from 165 to 330 lb-ft, depending upon the impeller blading selected by the user. Close match of engine and torque converter is ensured since an impeller with an optimum number of blades and pitch can be supplied in the standard housing. A variety of input and output configurations is available in the series 1500 unit. Typical applications include front-



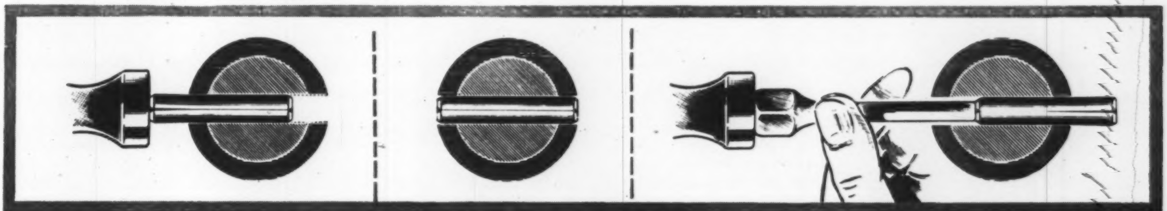
what makes this fastener DIFFERENT?



Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces.

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R40-54, 2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

☐ Rollpin Bulletin
☐ Elastic Stop nut Bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name ____________ Title ____________
Firm ____________
Street ____________
City ____________ Zone ______ State ______

—ITEM 638—
For More Information Circle Item Number on Yellow Card—page 19

JOT NAME, TITLE AND ADDRESS IN THIS SPACE
TO START YOUR FREE NELWELDER SUBSCRIPTION

Complete photo of this fighter pilot appears on the front cover of the June NELWELDER, industry's magazine of stud welding.

NELWELD

another way of saying..

JET-SPEED STUD WELDING
DOWNS COSTLY FASTENING

A nationwide fighter group of Nelson field engineers stands alerted to help you attack soaring costs in your plant or on your building site. This jet-action NELSON® stud gun end-welds studs to steel . . . brings fastening costs down to earth by eliminating drilling and tapping, reducing handling, and cutting rejects.

Let a field engineer conduct a reconnaissance mission; then pinpoint strategic locations for stud welding on your product. In the meantime jot your name above and you will receive monthly issues of the NELWELDER, a magazine aimed at helping you spot production short cuts.

NELSON STUD WELDING
Division of Gregory Industries, Inc.
LORAIN, OHIO

—ITEM 639—

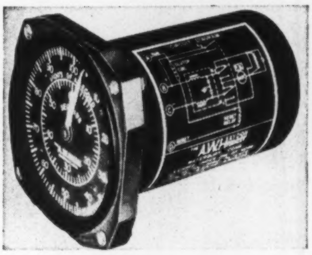
end loaders, industrial lift trucks, bucket loaders and yarders. **Twin Disc Clutch Co.,** Hydraulic Div., Rockford, Ill.

—Circle ITEM 479

DC Stop Clock

measures time intervals to ±0.20 per cent

Chronometrically governed dc motor in this series K15300 stop clock permits measurement of time intervals to ±0.20 per cent of reading over an ambient temperature range from −55 to 85 C. Electrical reset allows local or remote control or automatic operation for measuring successive time intervals. Weighing 23 oz, the unit is enclosed in a hermetically sealed housing with either AN-type or flanged mounting provisions. Operating voltage range of motor and clutch coil is 20 to 30 v dc, and accuracy of time interval measurement is independent of voltage. **A. W. Haydon Co.,** 232 N. Elm St., Waterbury, Conn.



—Circle ITEM 480

Polystyrene Formulations

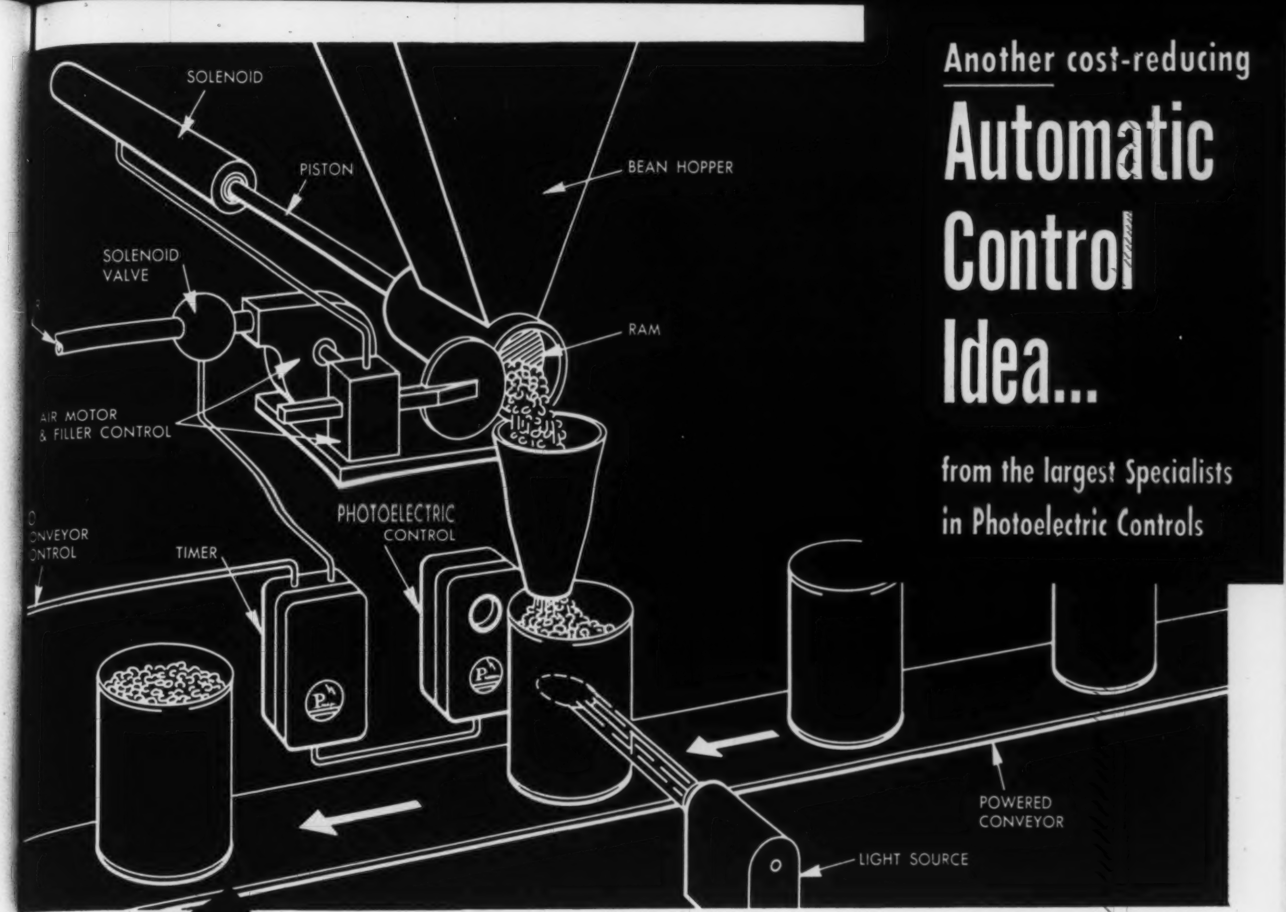
are general-purpose plastics with improved characteristics

New members added to the polystyrene family of plastics are: Styron 440 with high heat resistance, excellent surface finish, good moldability, and high impact resistance — applications include radio cabinets, calculator housings and automotive parts; Styron 665, a general-purpose polystyrene with characteristics tailored for the extrusion process—formulation resists shattering or cracking when cut off after extrusion, and can be employed for general-shape extrusions, bristles and thin film; Styron 689, developed for thin-sec-

Another cost-reducing

Automatic Control Idea...

from the largest Specialists in Photoelectric Controls



with Electronic Controls

FREE – 45 more ideas – Get this 76-page book. Shows in detail how designers of machines for many different industries have employed standard packaged electronic controls. Tells how they found new opportunities to reduce costs through simplification of design . . . how they developed order-getting user advantages. Shows you how easy it is to apply Photoswitch Controls for sorting, counting, starting, stopping, inspecting, indexing, adjusting, weighing, timing, limiting, safeguarding, etc.

SEND FOR YOUR COPY NOW ▶

Photoelectric Control of Batch Filling Process

Problem: To provide accurate, fast, fully-automatic control of filling aluminum bean-baking pots.

Solution: Empty pots move along a conveyor until one of them breaks the light beam of the photoelectric control at the filling station. The resulting electrical signal impulses a pre-set electronic timer. The timer instantly stops the conveyor, positioning the empty pot under the filling mechanism, and starts the automatic cycle of the filling mechanism. In the filling cycle, a filling-port cover is retracted, a measuring ram pushes a quantity of beans into the pot, and the filling port closes. At the end of the timed cycle, the timer automatically starts the conveyor again, the filled pot is moved away, and the light beam is restored until the next empty pot reaches the filling station.

Results: Reliable, high-speed filling of containers that are too light to provide sure operation of mechanical actuators. The timed cycle can be varied to allow for different filling times.

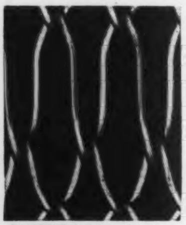
This control design is typical of thousands of successful Photoswitch Systems for automatic electronic control of machinery and processes. In Photoswitch's wide variety of high quality photoelectric controls, liquid level controls and electronic timers, you will probably find an exact answer to your automation requirements. Write for the helpful new Photoswitch Catalog . . . and if you have a specific problem, tell us about it.

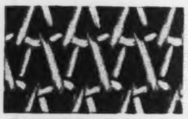
Photoswitch DIVISION
ELECTRONICS CORPORATION OF AMERICA
Dept. P2-5, 77 Broadway • Cambridge 42, Mass.

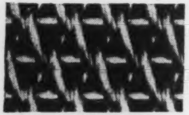
Send FREE copy of "Cutting Production Costs with Electronic Controls."

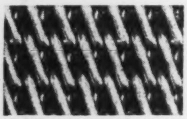
Name and Title..........
Company..........
Address..........
City.......... **State**..........

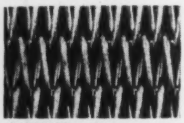
FIREYE DIVISION • COMBUSTION CONTROL DIVISION • BUSINESS MACHINES DIVISION
PHOTOCONDUCTOR-TRANSISTOR DIVISION • MARINE DIVISION • MILITARY DIVISION

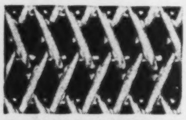

SECTIONAL—Simplest weave, for light loads where low initial cost is desired.

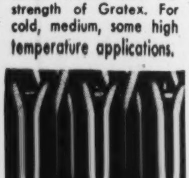

BALANCED—High tensile strength, low ultimate cost belting for operation up to 1300°F. Resists distortion, designed for straight travel.

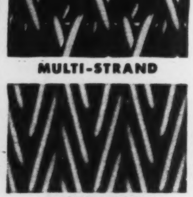

ROD-REINFORCED—Highest tensile strength and low thermal capacity. It is recommended for high temperatures, up to 2100°F. Undergoes minimum elongation and width contraction.

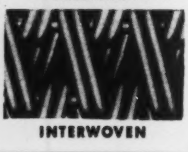

DUPLEX—Compact structure of great density provides high tensile strength. The close mesh provides smooth surface for carrying small parts and plastic materials.


GRATEX—Close spirals retain the advantages of Balanced weave, while adding strength. For cold, medium and some high temperature applications.


DOUBLE BALANCED—A widely used weave combining open mesh of Balanced weave with the strength of Gratex. For cold, medium, some high temperature applications.


MULTI-STRAND


CORDUROY


INTERWOVEN

How to select WOVEN WIRE CONVEYOR BELTS for Continuous Processing

As you know, woven wire conveyor belts are widely used for combining movement with processing in many continuous operations—heat treating metal parts; washing, blanching and freezing food products; annealing and decorating glassware; washing and curing chemicals and plastics.

However, there is no single type of belt construction suitable for all processes. Some require a smooth belt surface, some exceptional strength, others high corrosion resistance. That's why Cambridge has nine basic weaves available. Each is shown here with the important characteristics of the six most frequently used. The last three are special-purpose weaves for installations requiring exceptionally smooth surface and dense mesh for very small parts.

There are several factors that generally influence selection of weave, mesh size and metal or alloy from which the belt will be woven. Among them are: size, weight and shape of product to be handled; temperatures to which belt will be subjected; presence of wet or corrosive conditions. Even after these have been decided, overall belt construction must be designed to meet individual requirements—type of drive, selvage, support and special surface attachments must be selected.

You can see, then, that designing for continuous processing with woven wire conveyor belts is not a simple "nuts and bolts" job. Ramifications build up rapidly to demand the service of a specialist. That's why Cambridge maintains a staff of competent Field Engineers to help you select the Woven Wire Conveyor Belt to make your installation most efficient.

You can rely on the experience of these engineers to specify just the right belt for you. In addition, they are thoroughly familiar with basic conveyor design. For the name of your nearest Cambridge Field Engineer, look under "Belting, Mechanical" in your classified telephone book. Or, write direct. Also ask for 130-page Reference Manual of specifications and design information.

THE CAMBRIDGE WIRE CLOTH COMPANY,
DEPT. N, CAMBRIDGE 5, MARYLAND.

—ITEM 641—

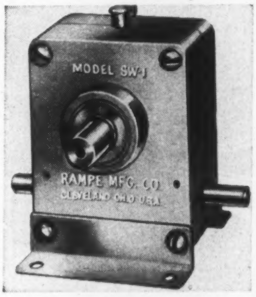
tion molding, deep draws, and other uses where accurate dimensional control must be maintained. This formulation is well suited for high-speed automatic molding operations and for large-area parts. **Dow Chemical Co.,** 919 Jefferson Ave., Midland, Mich.

—Circle ITEM 481

Gear Reducer

has glass fiber case and nylon gears

Model SW-1 gear reduction unit for use with fractional horsepower motors has a polyester glass fiber case, nylon gear and steel worm.



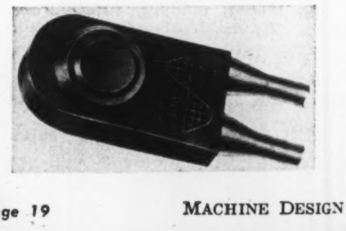
Reducer is available in seven sizes with speed reductions from 5¼:1 to 60:1. Solid and hollow style shafts are furnished. The hollow style is mounted as an integral part of the product with which it is used. Cases are available with or without mounting feet. **Rampe Mfg. Co.,** 14915 Woodworth Ave., Cleveland 10, O.

—Circle ITEM 482

Snap-Action Switch

withstands temperatures from −65 to 250 F

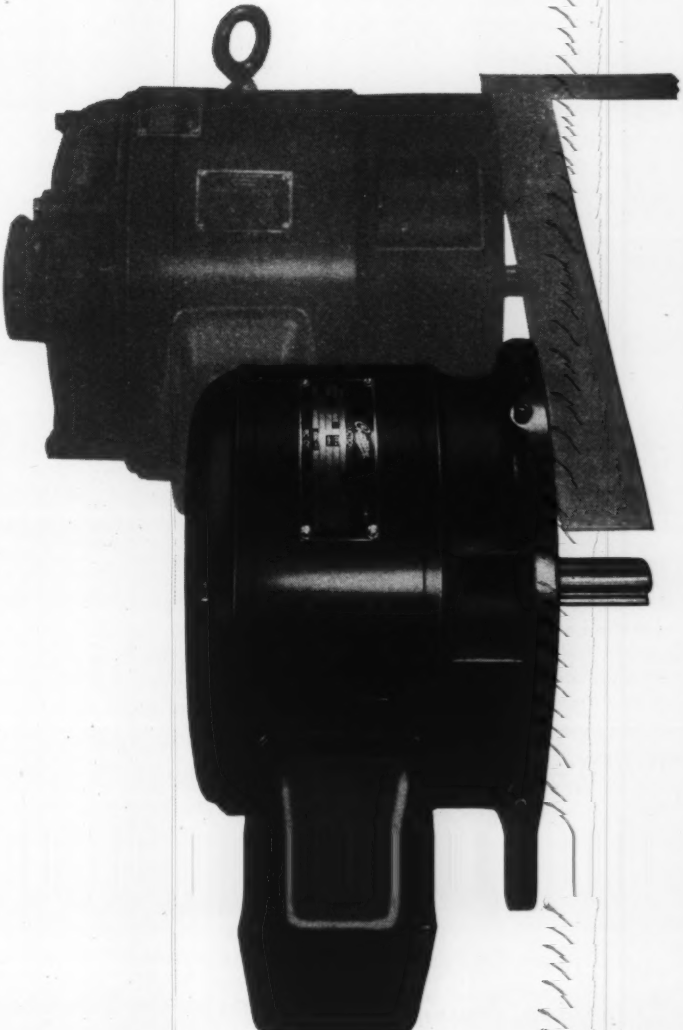
Klixon waterproof sine switch, designated Series C9180, is applicable where high shock and vibration resistance is required. Enclosed in a silicone rubber overmold, it is fully protected from water, oils, chemicals and dust, and operates accurately at temperatures from −65 to



A new dimension in motors!

SHORTER Century **Performance Rated© MOTORS**

SAVE SPACE...
SAVE WEIGHT



This new line of shorter, round-frame, end-mounted motors by Century can give you greater freedom in design and engineering. They meet modern demands for compactness and weight-saving ... with even better performance.

No special mountings are required! These shorter Century motors have full-size NEMA "D" flanges. They are interchangeable with all other popular makes of standard end-mounted motors. The shorter motors are available in sizes from 1 to 15 H.P... in open or totally enclosed fan-cooled frames ... for vertical or horizontal applications.

For full data, call your nearest Century Sales Office.

Performance Rated©
MOTORS
⅛ to 400 H. P.

CENTURY ELECTRIC COMPANY

1806 PINE ST., ST. LOUIS 3, MO. • *Offices and Stock Points in Principal Cities*

34

—ITEM 642—
For More Information Circle Item Number on Yellow Card—page 19

Promet
Engineered Bronze
BEARINGS-BUSHINGS
WEARING PARTS

Carry On During Temporary Lubrication Failures

Guarantee

SUPERIOR SERVICE OR MONEY BACK!

SEND PRINTS
and condition of operation for recommendations and quotations. No obligation.

Special formulas, developed for specific or unusual conditions, assure the best combination of physical properties. Will not cut, or stick to the shaft under ordinary operating conditions, nor powder under the most severe service.

Send for free literature and service data sheets.

THE
American Crucible
PRODUCTS CO.
"Bearing Specialists Since 1919"
1321 OBERLIN AVENUE, LORAIN, OHIO, U.S.A.

Please send free literature and service data sheets on Promet Bronze.
NAME________________
COMPANY________________
STREET________________
CITY & STATE________________

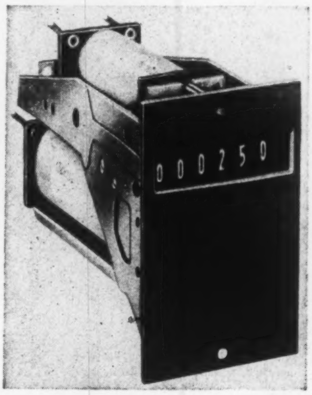
New Parts

250 F. Switch is also available with neoprene or vinyl overmold where ambient temperature ranges are not great and where abrasion resistance or low costs are determining factors. Minimum life is 25,000 cycles with rated load on both contacts when tested in accordance with military requirements. The switch has shock resistance to 200 *g*'s and vibration resistance from 0 to 500 cps at 20 *g*'s. Available with single-pole, single-throw or single-pole, double-throw switch action, the unit is approximately 7/16-in. high. **Metals & Controls Corp.**, Spencer Thermostat Div., 34 Forest St., Attleboro, Mass.

—Circle ITEM 483

Impulse Counter

has counting speed to 10 impulses per second



Sodeco six-digit electrical impulse counter with instantaneous electrical reset has side angle brace construction to provide strength. Suitable for flush mounting, it measures 1⅝ x 2⅜ x 4½ in. Standard model has a counting speed to 10 impulses per second; special models are also available with speeds to 25 impulses per second. Power requirements are low. Reset voltage can be different from the impulse voltage. **Landis & Gyr Inc.**, 45 W. 45th St., New York 36, N. Y.

—Circle ITEM 484

Foot Switch

for light-duty use

Class 9002 Type CG-1 foot switch is a two-pole type with double-break contacts. Designed for a

The abbot and the Musclebound File Clerk

The *abbot* studied the snapshot sympathetically and read the scented letter. "You must help me, kind sir," it pleaded. "For years I've struggled with overloaded, sticky file drawers. Look at me! I'm so musclebound people think I'm a lady wrestler instead of a file clerk."

The little man had a ready answer, this time. Seating himself at his photo-electronic typewriter, he wrote, "Ask your employer to invest in up-to-date files equipped with drawers that glide — smoothly and effortlessly — on ABBOTT *Deep Hardened* and *Tempered* carbon steel bearing balls. They open and close at the touch of a finger!"

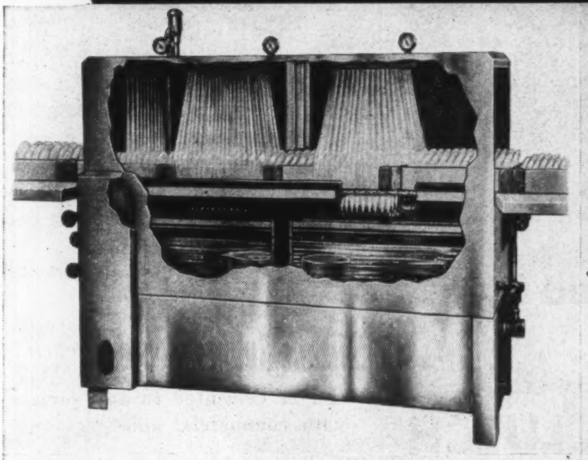
Abbott bearing balls have unlimited uses because they possess great shock resistance and perform efficiently under high load factors. These *special* properties come from Abbott's unique manufacturing processes and quality control which amply justify the name . . . ABBOTT — "the Ball with the Armored Heart".

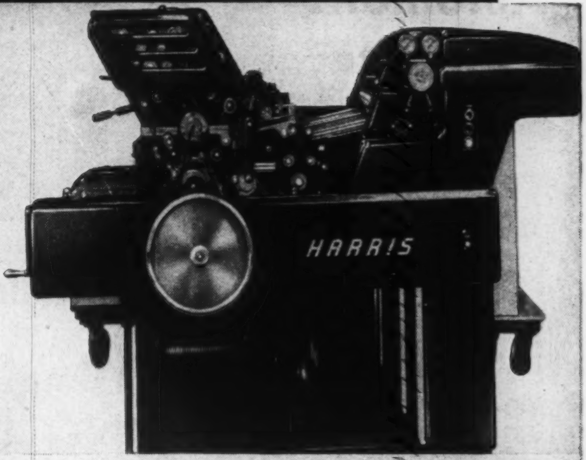
Have you a knotty problem which the abbot may solve with his vast knowledge of "The BALL — its nature and applications"? Write him about it at . . .

ABBOTT

The ABBOTT BALL Company
50 Railroad Place, Hartford 10, Conn.

DIAMOND
ROLLER CHAINS





CLUSTER PAK

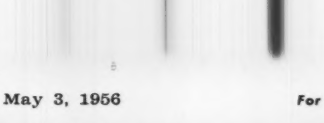
Help bring out the best in the machines you build

You have that feeling of confidence in the performance of the machinery and equipment you build when you entrust the various power transfer and drive duties to DIAMOND Roller Chains.

For simple applications or drives of fractional or a thousand horsepower, the smooth operation, long-life dependability and high maintained efficiency insure top steady output.

Now is a good time to re-examine your designs,—a good time to take advantage of practical recommendations the experienced Diamond Engineering Staff can offer.

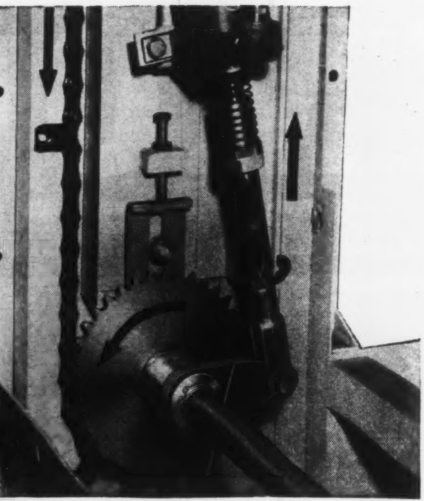
DIAMOND CHAIN COMPANY, Inc.
Where High Quality is Traditional
Dept. 435, 402 Kentucky Ave., Indianapolis 7, Indiana
Offices and Distributors in All Principal Cities

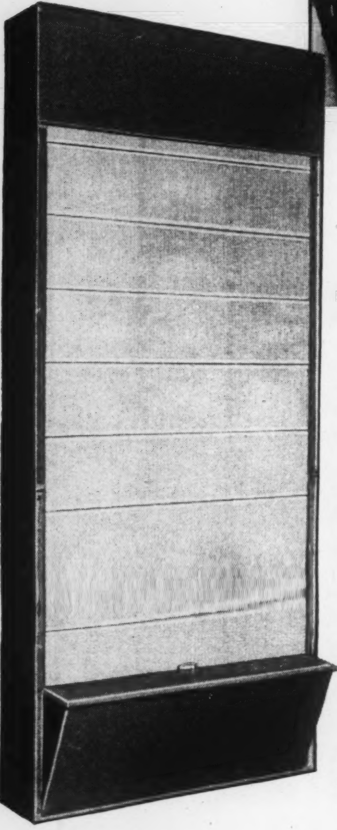


DIAMOND ROLLER CHAINS

—ITEM 645—
For More Information Circle Item Number on Yellow Card—page 19

Indexing Mechanism in Air-Maze Automatic Air Filter





...controlled by a

Marquette

SPRING CLUTCH

Air-Maze Corporation selected Marquette Spring Clutches to assure positive, trouble-free operation of its Automatic Air Filters. The metal filter forms an endless curtain, passing through an oil bath in the bottom of the assembly. Both the time cycle and the amount of travel can be varied as conditions require.

Marquette Spring Clutches are compact. They maintain their efficiency almost indefinitely. And they cost less than other types of clutches!

There are no restrictions on torque. Actual designs range from 6 in. lbs. to 25,000 ft. lbs. Speeds range from 1 to 10,000 r.p.m.

OVER-RUNNING or FREE-WHEELING CLUTCHES • INDEXING CLUTCHES
BI-DIRECTIONAL NO-BACK BRAKES • REVERSING CLUTCHES
SINGLE REVOLUTION CLUTCHES • DELAYED ACTION CLUTCHES

See us at the Design Engineering Show—Booth No. 605.

MARQUETTE METAL PRODUCTS DIVISION
CURTISS-WRIGHT
CORPORATION • CLEVELAND 10, OHIO

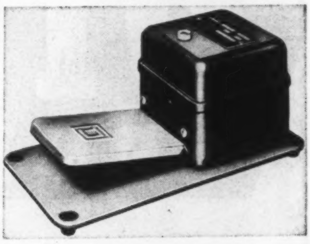
SPRING CLUTCHES

MARQUETTE METAL PRODUCTS DIVISION
1141 Galewood Drive, Cleveland 10, Ohio

Please send manual describing the functions, applications and operations of the basic types of Spring Clutches.

COMPANY______________________________
NAME______________________________ TITLE_______________
ADDRESS______________________________

—ITEM 646—



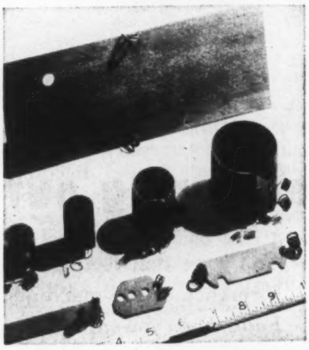
variety of light-duty uses, it can control a 1-hp motor at 110 or 220 v ac. Applications range from controlling home workshop tools to small industrial machine tools. **Square D Co.,** 4041 N. Richards St., Milwaukee 12, Wis.

—Circle ITEM 485

Silicone-Rubber Heaters

can be cemented to any surface with commercial adhesives

Thermolastic heaters of silicone rubber, with dissipation ratings exceeding 30 w/sq in., can be furnished with flat, cylindrical or conical shapes. Sizes run from ¼ sq in. to 10 sq ft, and thicknesses range down to 0.020-in. Operating temperature limit is 446 F; dielectric strength is 2000 v dc minimum. Heaters can be cemented to any surface by means of room-temperature curing adhesives. **Cox & Co. Inc.,** 115 E. 23rd St., New York 10, N. Y.



—Circle ITEM 486

Metal Mount

has natural frequency of 7 to 10 cps

W339 Adjust-O-Mount protects industrial machinery against vibration and shock. Having a diameter of 7$\frac{11}{16}$ in., the mount is available in

To install HYLUG on rectangular wire . . .

Pre-round wire to circular section . . .

Insert pre-rounded wire into HYLUG . . .

Compress HYLUG on wire with "quad" indent

get around your magnet wire problems with the

MAGNECRIMP METHOD

FOR PRE-ROUNDING MAGNET WIRE TO FIT STANDARD LUGS

Until now, terminals have been trouble spots in magnet wire conduction. Now, the new Burndy Magnecrimp method provides inexpensive compression terminations of maximum conductivity and mechanical strength . . . and resistant to corrosion and vibration, too.

"Magnecrimping" pre-rounds square or rectangular magnet wire to the proper size for standard Burndy Hylugs. A compound die for sizes up to 1/0 round re-shapes conductors singly or in combinations. Wire and Hylug form a tight joint. No wasted metal from oversized lugs.

The pre-formed wires in the Hylug are then compression-connected with a standard Burndy quadrangular crimp. Rounding and compression work-hardens the copper wire, strengthening the joint up to 90% of rated breaking strength of conductor.

For more detailed information, send for Burndy Bulletin MAG 55. For recommended die sets and terminals, write:

BURNDY

56-3

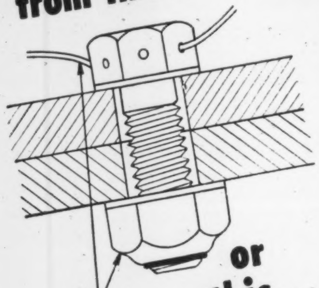
Norwalk, Connect. • Toronto, Canada • Other Factories: New York, Calif., Toronto • Export: Philips Export Corp.

—ITEM 647—

For More Information Circle Item Number on Yellow Card—page 19

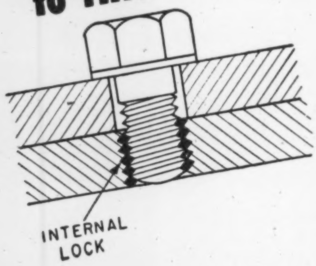
How to Do Away With Lock Nuts and Lock Wiring use HELI-COIL* Screw-Lock Inserts

from this...



or this...

to THIS



Screw-Lock Inserts meet AN-N-5b and MIL-N-25027 military specifications for lock nuts.

For years designs requiring lock nuts or lock wiring have plagued designers with problems of space, weight and costs. Each lock nut, even a small one, takes space, has weight and costs money. Every bolt locked with wire requires a through hole in the head, positioning and wiring. The simplicity of many a superior design has been lost due to these cumbersome methods of fastening.

Now for the first time good designers can do away with these "design plaguers." They can accomplish the same end results plus a saving of weight, space and money by a new revolutionary concept in fasteners—*Heli-Coil* Mid-Grip Screw-Lock Inserts. This new fastener is a stainless steel wire insert with locking threads. It can be installed easily and puts the locking effect *inside* the tapped hole—protects the tapped threads for life—and locks the mating screw or the bolt with the same torque as a lock nut. This Screw-Lock Insert not only provides a stainless steel protecting thread, locks the screw or bolt, but most important of all—eliminates the space and weight of a lock nut—the wiring necessary in lock wiring.

Heli-Coil Mid-Grip Screw-Lock Inserts can readily be distinguished from regular non-locking *Heli-Coil* Inserts by their distinctive red color.

*Reg. U.S. Pat. Off.

HELI-COIL SCREW-LOCK INSERTS
Products of Heli-Coil Corporation, Danbury, Conn.

HELI-COIL CORPORATION
125 SHELTER ROCK LANE, DANBURY, CONN.

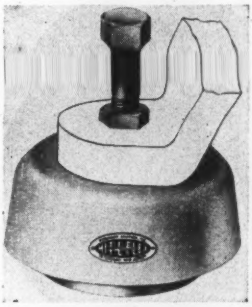
☐ NEW—Design manual available on regular *Heli-Coil* Screw Thread Inserts.
☐ RUSH complete design data on *Heli-Coil* Mid-Grip Screw-Lock Inserts.
☐ WIRE your nearest representative to phone me at______
☐ Send me, FREE, *Heli-Call*, your case history periodical.

Name______ Title______
Company______
Address______
City______ Zone____ State______ 3053

☐ Heli-Coil Corporation has an outstanding staff of Thread Fastening Engineers. If your company would be interested in a "Thread Problem Symposium" CHECK HERE.

IN CANADA: W. R. WATKINS CO. LTD., 41 Kipling Ave. S, Toronto 18, Ont.

—ITEM 648—



three models with load carrying capacity range of 1000 to 10,000 lb per unit. Natural frequency of 7 to 10 cps effectively absorbs vibration shock and noise. Stainless-steel resilient elements offer maximum damping and ensure long life. Performance is unaffected by oil, water, solvents, dust or extreme temperatures. Built-in leveling bolt and jam nut permits quick installation on uneven floors. The mount can also be used in conjunction with inertia blocks for machines with high center of gravity. **Robinson Aviation Inc.,** Teterboro Air Terminal, Teterboro, N. J.

—Circle ITEM 487

Fluorocarbon Plastics

in treated sheets for cementing to wood or metals

Specially treated on one or both sides, Califilm sheets (Flurothene, Kel-F) and Kelon-F sheets (Kel-F) can be bonded with commercial adhesives to steel, aluminum, wood and a variety of other materials. The sheets have excellent electrical and thermal properties and form a low-friction, corrosion resisting surface on parts such as tank liners, conveyors, jigs and fixtures, pipe ducts, etc. Treated Califilm is available in 0.005 to 0.015-in. thicknesses and widths to 16-in.; treated Kelon-F sheets come in thicknesses from 0.015 to 0.250-in. **Shamban Engineering Co.,** 11617 W. Jefferson Blvd., Culver City, Calif.

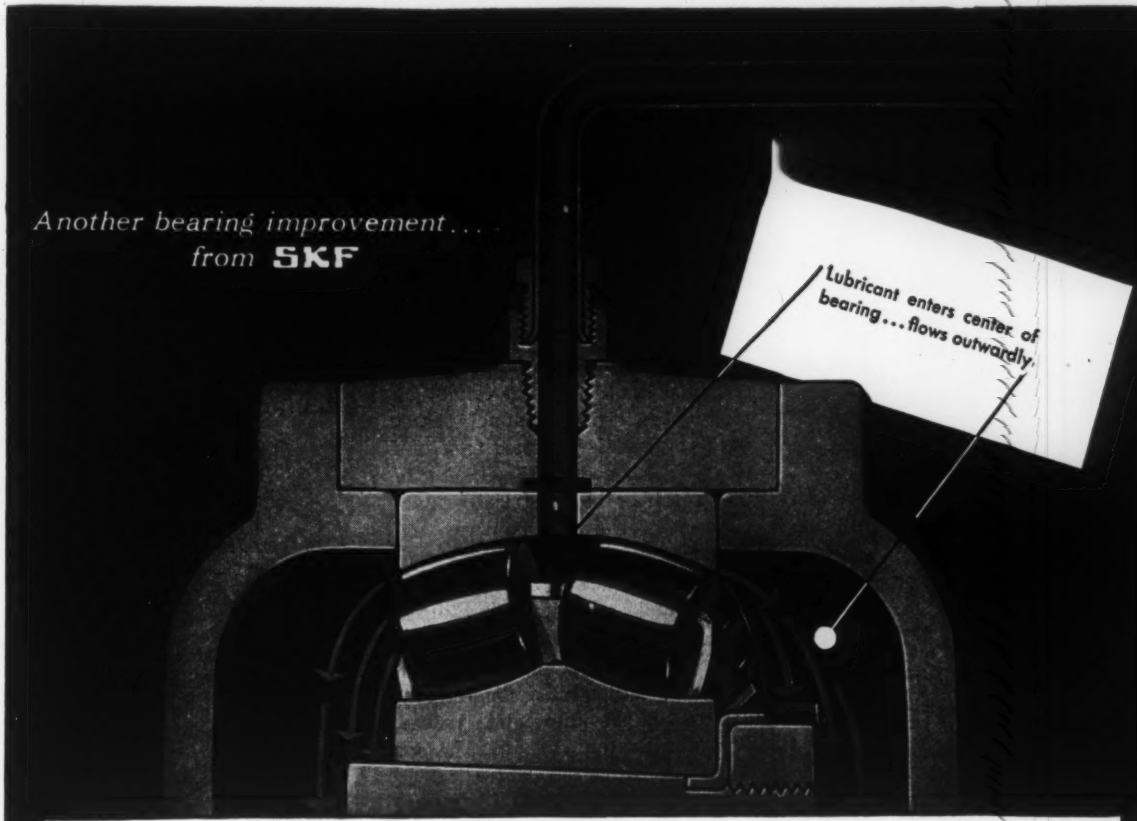
—Circle ITEM 488

Pressure Switch

has two independent switching elements

Designated model 432, this Meletron switch first signals rise or fall of pressure and then shuts

Another bearing improvement...
from **SKF**



NOW AT NO EXTRA CHARGE—

SKF's improved method of lubricating large spherical roller bearings

To make the lubricant effective it should be located where needed—in the bearing. Also, new lubricant, when added, should enter where it does the most good—in the bearing.

For these reasons, all future production of **SKF** double row spherical roller bearings above 240 mm O.D. (9.4488") will be made with three equally spaced drilled holes in the center of the outer ring without any extra charge to our customers. *This permits the lubricant to enter the center of the bearing.*

With the lubricant (either grease or oil) being introduced into the center of the bearing, all working surfaces are quickly and completely covered. In addition, the outward flow flushes out the old lubricant, and with it, any abrasive dust, dirt, moisture or other impurities.

And where circulating oil lubrication is required, there is a continuous flushing and cooling of the bearing.

This is another example of how **SKF** helps you to obtain longer bearing life.

7760

Consult your **SKF** District Office today for complete information so that you can be the first to incorporate into your products this improved method of lubricating large spherical roller bearings.

SKF®

BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—manufacturers of **SKF** *and* **HESS-BRIGHT®** *bearings.*

—ITEM 649—
For More Information Circle Item Number on Yellow Card—page 19

are you *up in the air* with a time control problem?

Visit us at
BOOTH
1000
at the Design
Engineers Show!

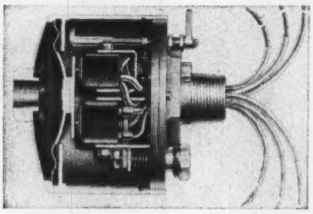
We're happy to help you solve your timing problems! We can show you how a Mark-Time time control unit can increase the utility, versatility, and sales appeal of your next design.

MARK-TIME

M. H. RHODES, INC.
HARTFORD 6, CONNECTICUT

—ITEM 650—

New Parts

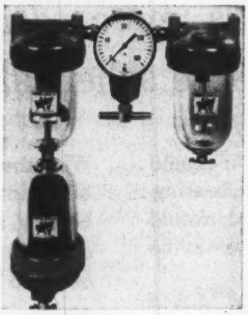


down the controlled system if rise or fall continues beyond a predetermined limit. System cannot be reactivated with manual reset until pressure is returned to a safe level. Each switching element in the unit can be electrically independent of the other, or two external leads can be used to control a single circuit between maximum and minimum pressures. Switch is available in three classes of proof pressures, 6, 30 and 120 psi, with adjustable range from 0.05 to 100 psi. **Barksdale Valves,** Pressure Switch Div., 5125 Alcoa Ave., Los Angeles, Calif.

—Circle ITEM 489

Air Control Assembly

adds oil mist to regulated compressed air

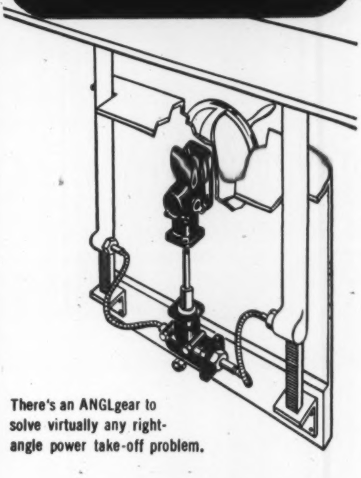


This assembly automatically filters, regulates and lubricates compressed air. Sludge is automatically trapped by the filter. Automatic drain trap at the bottom of the filter collects moisture to eliminate periodic draining maintenance. When the cleaned air is regulated to the desired pressure, an oil mist is added by the lubricator. The lubricated air is carried to the operating parts of the pneumatic equipment. Visibility of operation is provided while up to 98 per cent of free moisture is removed at a negligible loss in air pressure. **Airmatic Valve Inc., 7317 Associate Avenue, Cleveland 9, O.**

—Circle ITEM 490

ANGLgear

RIGHT
for
right
angles!



There's an ANGLgear to solve virtually any right-angle power take-off problem.

Name your industry — textile, canning, processing, electronics, chemical, packaging, petroleum, ceramics, metal fabricating. It's bound to be one in which ANGLgear power take-offs have solved right-angle transmission problems again and again.

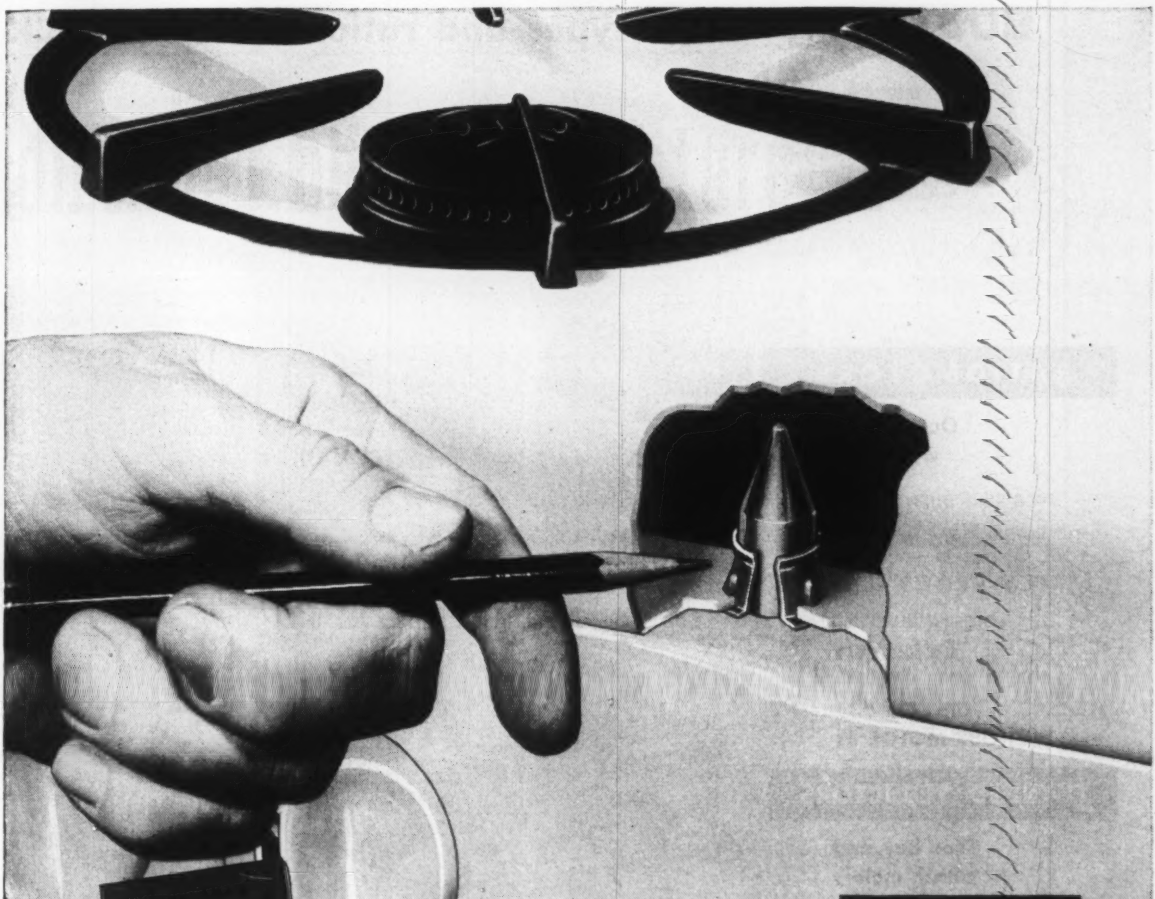
Standardized ANGLgear units have won their wide acceptance because they meet design and engineering requirements fully for compactness, light weight and high operating capacity. Designed for either manual or power-operated control systems, they are available in 12 models —with ⅓, 1, or 3 hp rating, with 2-way or 3-way shaft extensions, and with either 1-1 or 2-1 gear ratio. The right-angle transmission problem that ANGLgear *can't* solve is rare indeed.

You'll find our literature in the product design file of Sweet's Catalog. Contact your local distributor, or write to us, for additional information.

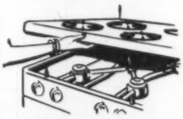
AIRBORNE

AIRBORNE ACCESSORIES
CORPORATION
HILLSIDE 5, NEW JERSEY

—ITEM 651—



Blind attachments made at 82% lower cost ...with Tinnerman SPEED CLIPS®!

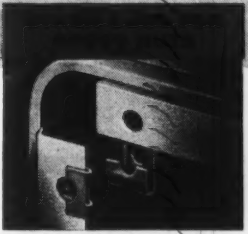


Automatic Range Company, Brooklyn, cut assembly costs on its Royal Rose Ranges 82% with a Tinnerman tubular-type Speed Clip®. It locks the removable range tops securely in place. Automatic Range designers were able to eliminate a costly bracket, a wire form catch and a spot welding operation with this engineered fastener.

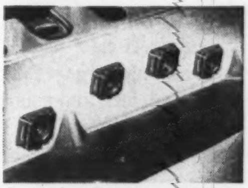
One-piece, spring-steel Speed Clips are quickly and easily snapped into punched holes in the range's top. Self-retained, the Speed Clip grips the mating stud in the front panel flange with pin-point accuracy under live spring tension for a firm, vibration-proof attachment. Yet the top is readily raised or removed for cleaning or servicing . . . no tools required!

Tinnerman produces more than 8,000 different types and sizes of Speed Nut brand fasteners. They are designed to help you make faster, easier, more efficient attachments at substantial assembly savings. Consult your Tinnerman representative for complete information on standard or specially engineered Speed Nuts. Also write for your copy of "Speed Nut Savings Stories."

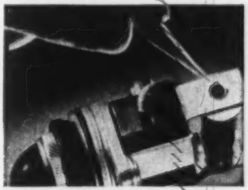
TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO
Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.



In a heating-unit assembly, "J" type Speed Nuts eliminate problems of hole misalignment and paint clogging.



On truck radiators, costly retapping of flash-clogged threads of weld-type fasteners is eliminated by Speed Grips.



On an indicator light, Tubular Speed Clip replaces 4 parts, reduces parts cost and handling.

TINNERMAN
Speed Nuts

FASTEST THING IN FASTENINGS®

—ITEM 652—
For More Information Circle Item Number on Yellow Card—page 19

BOSTON Gear 100 SPEED REDUCERS

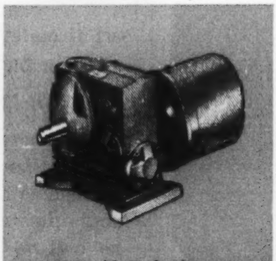
1064 types and ratios — FROM STOCK

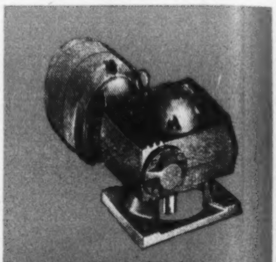
Make speed reduction

RATIOMOTORS

Output RPM
.49 to 175

Horizontal Right
Angle Drive


Double Reduction
Horizontal Parallel Drive

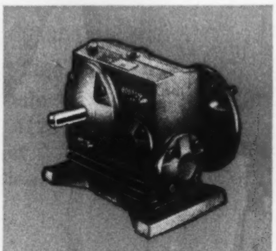

Vertical Right
Angle Drive

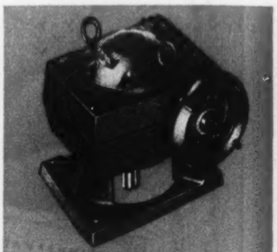
Ratiomotors
are sold also
WITHOUT MOTOR as

FLANGED REDUCTORS

You buy and
attach motors
of your choice

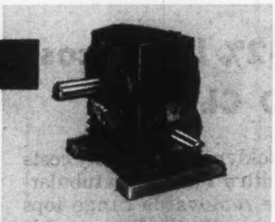
Horizontal Right
Angle Drive

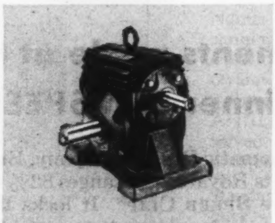

Double Reduction
Horizontal Parallel Drive


Vertical Right
Angle Drive

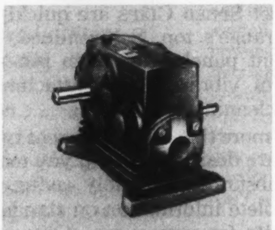
REDUCTORS

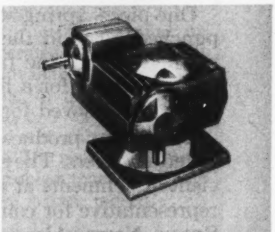
Ratios 1:1 to 3600:1
Fan-cooling
optional
on larger sizes


Horizontal Right Angle Drive
Worm Gear over


Horizontal Right Angle Drive
Worm Gear under

Vertical Right
Angle Drive

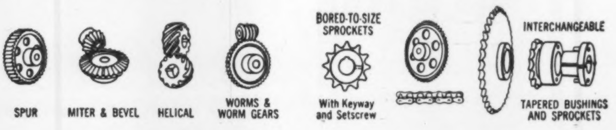

Double Reduction
Horizontal Parallel Drive


Double Reduction
Vertical Right Angle Drive

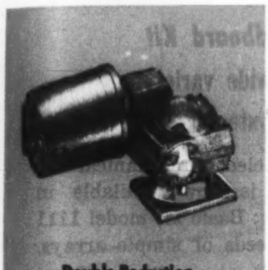
At the
DESIGN ENGINEERING SHOW
— see the big display and demonstration of 100 SERIES Speed Reducers,—and other new BOSTON GEAR Transmission Products. Visit the
BOSTON Gear BOOTH 514

7124 "OFF-THE-SHELF" TRANSMISSION PRODUCTS

— STANDARD STOCK GEARS — SPROCKETS & CHAIN —


SPUR
MITER & BEVEL
HELICAL
WORMS & WORM GEARS
BORED-TO-SIZE SPROCKETS
With Keyway and Setscrew
INTERCHANGEABLE
TAPERED BUSHINGS AND SPROCKETS

a COST-REDUCTION feature...



Double Reduction
Vertical Right Angle Drive

Double Reduction
Vertical Right Angle Drive

in *any* transmission design

When you design around the 100 SERIES, you can be sure that any model you need is available promptly, — from stock. You can be sure, also, that any BOSTON Gear Speed Reducer will take top-rating in any test for operating efficiency, and lasting power economy.

You save time in planning, too, because you can get any needed information immediately in a phone call to your local BOSTON Gear Distributor's transmission specialist. Boston Gear Works, 64 Hayward St., Quincy, Mass.

No downtime for motor repairs

New "COMBINATION" design of 100 SERIES RATIOMOTORS permits easy motor change... continued operation with spare

Standard end-mounted motor is easily detachable, can be changed in minutes. Gear unit is undisturbed, preserving alignment. Also, original motor can be replaced with another type (explosion-proof, etc.) at anytime.

Call your BOSTON Gear® DISTRIBUTOR

For nearest Distributor, look under "GEARS" in the Yellow Pages of your Telephone Book.

Ad No. 56

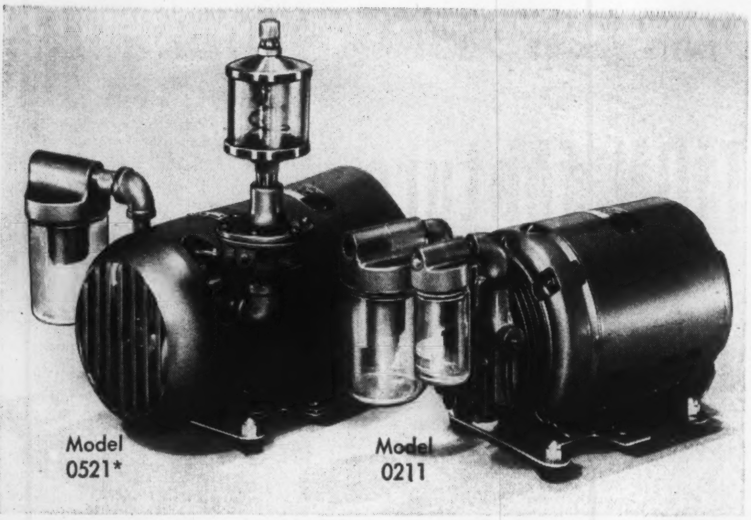
FROM YOUR DISTRIBUTOR - AT FACTORY PRICES ASK FOR CATALOG

SPEED REDUCERS — BEARINGS — OTHER PRODUCTS

Oil-Impregnated BOST-BRONZ

REDUCTORS RATIOMOTORS FLANGED REDUCTORS BOSTON GEAR BRONZE BEARINGS BALL BEARINGS PILLOW BLOCKS UNIVERSAL JOINTS COUPLINGS

—ITEM 653—
For More Information Circle Item Number on Yellow Card—page 19



Get 10 Integral-Motor-Pump advantages in two **NEW** types (three models) of

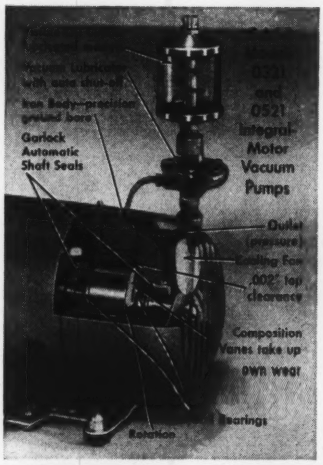
GAST rotary vane **AIR PUMPS**

Designers seeking a dependable vacuum or pressure source for industrial instruments, vending machines, air gauge circuits, air sampling, laboratory equipment, printing and packaging machinery, etc., will find these *new* Gast Integral-Motor Air Pumps highly advantageous, especially where compactness and portability count. Consider these outstanding features:

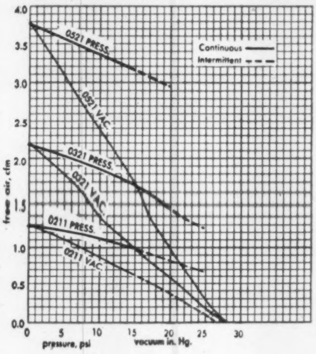
1. Latest type G.E. "Form G" motors.
2. More compact than any pump of equal capacity.
3. Total weight reduced ⅓—cuts shipping costs.
4. Motor mounting time and labor eliminated.
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
7. Positive displacement, pulseless air delivery.
8. Improved appearance—smoother exterior.
9. Dependable for original equipment; plant use.
10. Forced air fan cooling on Models 0321 & 0521.

Write for new Bulletins V-356 and P-356!
GAST MANUFACTURING CORP.,
P. O. Box 117-P, Benton Harbor, Mich.

*0321 similar in appearance.


Vacuum Lubricator with auto shut-off
Iron Body—precision ground bore
Garlock Automatic Shaft Seals
0321 and 0521 Integral-Motor Vacuum Pumps
Outlet (pressure)
Cooling Fan
.002" top clearance
Composition Vanes take up own wear
Bearings
Rotation

Performance-Vacuum & Pressure



Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

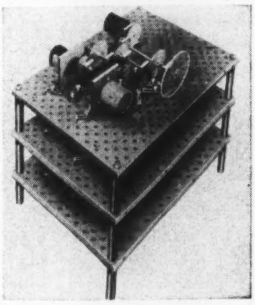
—ITEM 654—

ENGINEERING DEPARTMENT EQUIPMENT

Servo Breadboard Kit

contains wide variety of servo-system parts

Servoboard electro-mechanical assembly kit is now available in three models: Basic kit model 1111 meets the needs of simple arrays, occasional use, and university laboratory budgets; Standard kit model 1112 satisfies requirements for average use; Master kit is intended for situations where many projects are under way and the purchase will be charged to capital equipment. Holes in redesigned mounting board are now tapped, and board and leg design allows stacking of several boards. Kits include large group of prebored hangers, solid-hub and split-hub gears, adapter gears, mitre gears, bevel gears, couplings and other basic components. Also available are magnetic clutches, differentials, limit stops and switch assemblies with associated cams and pulse disks. **Servo Corp. of America**, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.



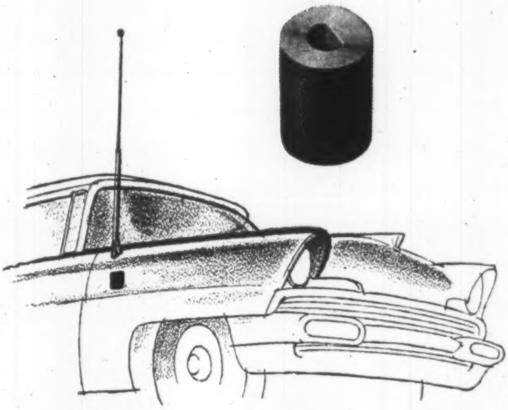
—Circle ITEM 491

Portable Drafting Machine

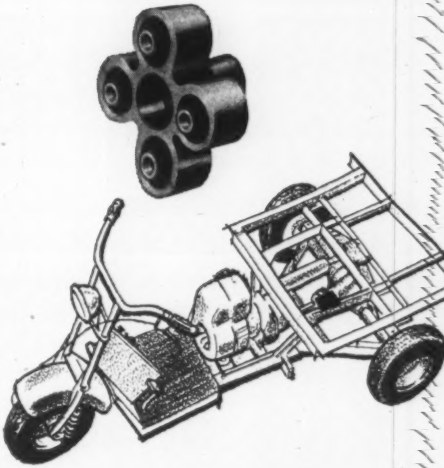
for field sketching and drafting

Small enough to fit into a man's pocket, this portable drafting machine is intended for drafting or sketching in the field. Area covered measures 11 x 17 in. and the unit clamps to any drawing board or sketch pad. Construction is an-

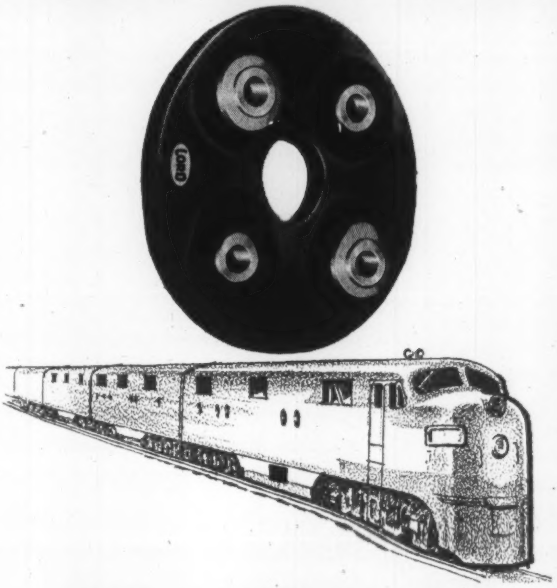
no lubrication, less vibration and noise with low-cost LORD flexible couplings



1/50 hp @ 5000 rpm—Flexible coupling to drive electrically actuated radio antenna on automobiles was Lord-designed to overcome noisy operation of all-metal unit. In addition to noise reduction, coupling accommodates 8° misalignment.



5 hp @ 3200 rpm—Low-cost Lord Flexible Coupling replaced costlier universal joint on three wheel industrial motor scooter. Used on drive shaft, it accommodates misalignment, eliminates lubrication.



300 hp @ 1200 rpm—Lord engineered this flexible coupling for a high-capacity application on locomotive auxiliary drive shaft. Unit provides desired vibration isolation and noise reduction, also accommodates slight shaft misalignment.

LORD engineers have special skills in designing Flexible Couplings for your specific requirements. Precision LORD bonded rubber units such as the examples shown here, effectively reduce noise and vibration on all types of installations from small automotive units to huge locomotives.

Bring your special flexible coupling problems to LORD. Specialized LORD engineering has solved many complex coupling problems and can probably solve yours with a low cost, high-efficiency bonded rubber coupling that will give outstanding performance. Simply call or write the LORD Field Office nearest you or the Home Office today.

LORD MANUFACTURING COMPANY • ERIE, PENNSYLVANIA

NEW YORK, N. Y. - Circle 7-3326 • PHILADELPHIA, PA. - LOcust 4-0147
CLEVELAND, OHIO - SUperior 1-3242 • DAYTON, OHIO - Michigan 8871
DETROIT, MICH. - TRinity 4-2060 • CHICAGO, ILL. - Michigan 2-6010
DALLAS, TEXAS - RIverside 3392 • LOS ANGELES, CAL. - HOllywood 4-7593
"In Canada—Railway & Power Engineering Corporation Limited"

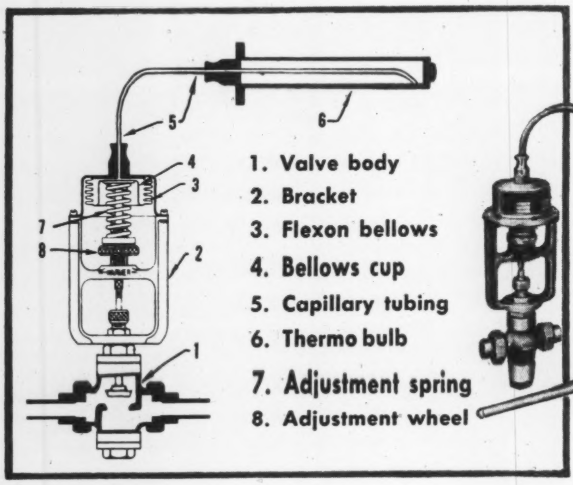
LORD
BONDED RUBBER

*designers
and producers
of bonded
rubber
products
since 1924*

—ITEM 655—
For More Information Circle Item Number on Yellow Card—page 19

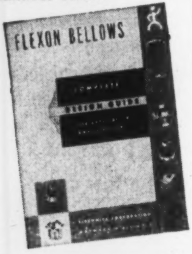
FLEXON® BELLOWS Design Briefs

Flexon Bellows Converts Vapor Pressure to Closing Force in Temperature Regulator



FLEXON® OFFERS THE COMPLETE BELLOWS SERVICE

Flexonics Corporation manufactures a complete range of bellows and bellows assemblies in brass, bronze or stainless steel.



The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy, today.

Lawler thermostatic temperature regulators are self contained vapor-pressure-operated devices for automatically regulating the flow of liquid or steam through a valve. Manufactured by Lawler Automatic Controls Inc., Mount Vernon, New York, the type "S" illustrated is only one of the Lawler Line of thermostatic controls that rely on Flexon Bellows to translate vapor pressure into positive action of the valve disc, thereby regulating flow.

If your product must be temperature sensitive—or pressure sensitive—specify Flexon Bellows developed by cost-conscious Flexonics engineers who know how to combine performance with economy.

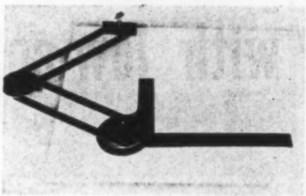
Let us examine an outline of your requirements—we may be able to show you the way to lower costs.

FLEXON® QUALITY
proved in service and backed by over 54 years manufacturing experience

B-35

Flexonics Corporation
FLEXON BELLOWS DIVISION
1339 S. THIRD AVENUE, MAYWOOD, ILLINOIS
FORMERLY CHICAGO METAL HOSE CORPORATION
Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Engineering Equipment



odized aluminum; all scales are machine calibrated to 0.0005-in. **David Miller & Associates,** P. O. Box 572, Beverly Hills, Calif.

—Circle ITEM 492

Vibration Meter

has all-transistor circuit

Utilizing two 22½ v dry batteries as a self-contained power source, this type 1-128 transistorized vibration meter is completely portable. Frequency range is 10 to 1000 cps. Rugged construction of the instrument enables it to produce direct, unambiguous amplitude measurements under severe environmental conditions. **Consolidated Electrodynamics Corp.,** 300 N. Sierra Madre Villa, Pasadena, Calif.

DISPLACEMENT
VIBRATION METER
CONSOLIDATED ENGINEERING

—Circle ITEM 493

Strip-Chart Recorder

draws rectilinear record of millivolt input

This low-cost Servo-Graphic strip-chart recorder, which operates as a self-balancing potentiometer, provides rectilinear tracings of temperatures, speeds, pressures, resistances, or other variables that can be represented by a dc signal in the millivolt range. Accuracy of the instrument is 1 per cent, and input for full-scale indication is 100 mv. Chart is sprock-

—ITEM 656—

CYPAK
NOT ½ MEMORY
WESTINGHOUSE ELECTRIC CORP.

THIS IS CYPAK

for more flexible industrial control

In the flexibility of CYPAK* lies the challenge to throw out mechanical relay limitations and simplify control for more automated production.

For example, CYPAK systems employ just four different component panels. They provide, in the most practical form, the four basic logic functions of computer science. With infinite combinations of these panels you can direct, far more simply, a greater range of equipment operations.

Because the magnetic "make and break" of CYPAK circuits has no moving parts, it is five times faster than mechanical relays. It's the basic reason for CYPAK flexibility in handling control signals.

In addition, CYPAK systems are designed for physical flexibility. A common power channel is the backbone of each system. Into it CYPAK elements are *plugged in, locked in,* and signal terminals joined. In this manner, the system is easily expanded or replacements made after installation.

Look into all the new opportunities in CYPAK

by calling your Westinghouse sales engineer.

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—ITEM 658—
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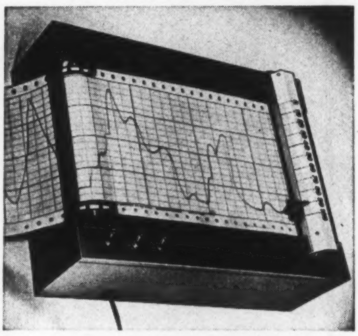


et driven by synchronous motor. The portable instrument measures 6 x 9½ x 14 in. and weighs 15 lb. **C. H. Stoelting Co.,** 424 N. Homan Ave., Chicago 24, Ill.

—Circle ITEM 494

Miniature Load Cell

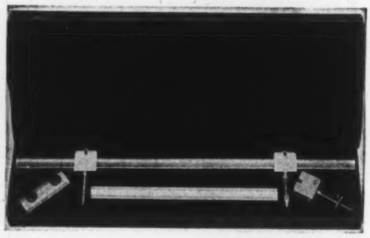
measures compressive forces to 10,000 lb

For use where space is limited, the SR-4 load cell has a diameter of 2 in. and is 2¾ in. high. Capacities from 2000 to 10,000 lb can be supplied for specific applications. Cells are not intended to replace larger cells of the same capacities since side-load sensitivity is lower in the smaller cells. Calibration accuracy is within ±0.25 per cent of full range at 70 F. Resistance across power terminals is 120 ohms. **Baldwin-Lima - Hamilton Corp.,** Philadelphia 42, Pa.

—Circle ITEM 495

Beam Compass Set

has coupling and pen slide



No screws or clamps are used in this Era beam compass, hairline adjustments being made instead with spring-loaded thumb rollers. Coupling eliminates the need for extra length beams. Compass material is anodized aluminum, satin finished, and set is furnished in a fitted box. **Engineering Research Associates Inc.,** Hazel Park, Mich.

—Circle ITEM 496

ROCKFORD

FIRST

Using a new type friction material of recent development, ROCKFORD was the FIRST to engineer these new materials into MORLIFE Clutches and Clutch Plates. They reduce clutch size and engaging pressure, operate longer without adjustment or plate replacement — and avoid down-time caused by burned or warped plates in heavy duty tractors, trucks, tanks, cranes, power units, shovels, bulldozers, earth movers and other heavy duty machines.

MORLIFE*

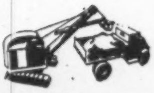
CLUTCHES and CLUTCH PLATES

*TRADE MARK

"MORLIFE clutch has gone 851 hours without slipping or adjustment."

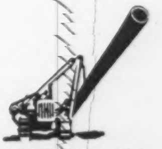
"MORLIFE clutches last 950 hours longer, without adjustment."

"MORLIFE clutch needs adjustment once a month, instead of daily."



"MORLIFE requires lighter handle pull and one tenth the adjustments."

"MORLIFE clutch going strong after 1695 hours, working in sand."



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400% MORE LIFE

100% MORE TORQUE

50% MORE HEAT RESISTANCE

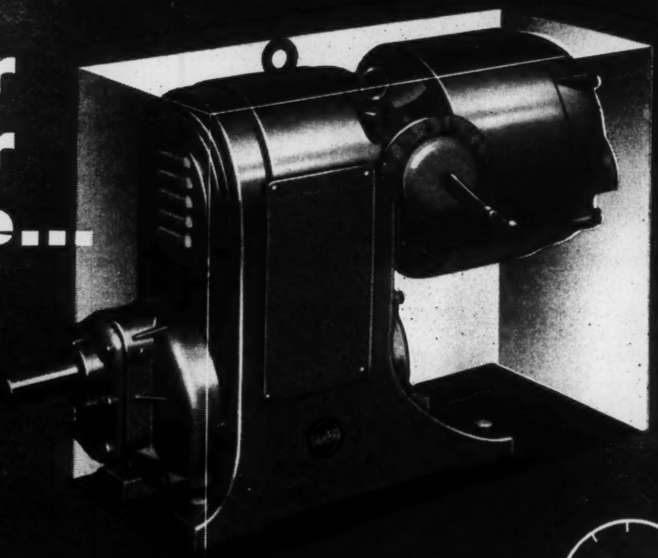
Before you approve specifications for your next models, it will pay you to investigate how MORLIFE Clutches will add to the service life of your product and reduce the number of stops for adjustments and repairs. It also will pay you to recheck specifications for your present models. For information covering operating characteristics, write Department E.

ROCKFORD Clutch Division BORG-WARNER

311 Catherine Street, Rockford, Illinois, U.S.A.

CLUTCHES

—ITEM 659—



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Recent Books

Failure of Machine Parts, Prevention and Cure. *Edited by Rune Evaldson and Charles Lipson; 240 pages, 8¼ by 11 in., paperbound; published by the Michigan Press, University of Michigan, Ann Arbor, Mich.; available from* MACHINE DESIGN, **$10.00** *postpaid.*

This volume contains the summaries of twelve lectures which comprise a special course of instruction. Various aspects of the problem of preventing or remedying the failure of machine parts are treated by eight lecturers from industry and two from the university. Subjects of the sessions include: Surveys of the problem and causes of failure; treatment of initial design, development and field testing; treatment of stress, strength, vibration, shock, impact, metallurgy and fabrication; service loads; use of computing machines; control of wear; and the appearance of failed parts.

•

Aircraft Gas Turbines. *By C. W. Smith;* 448 *pages,* 5¾ *by* 9 *in., clothbound; published by John Wiley & Sons Inc.,* 440 *Fourth Ave., New York* 16, *N. Y.; available from* MACHINE DESIGN, *$8.75 postpaid.*

This book presents the basic principles in the design of gas turbines and their components. Greater emphasis is placed on theoretical aspects than on mechanical and structural details, and much of the material is applicable to stationary as well as to aircraft power plants. Chapters cover the principles of aircraft propulsion, the Braydon cycle and other gas turbine cycles, gas dynamics, theory of flow, intake and exhaust systems, energy transfer, compressors, combustion chamber design, elements of dynamic simi-

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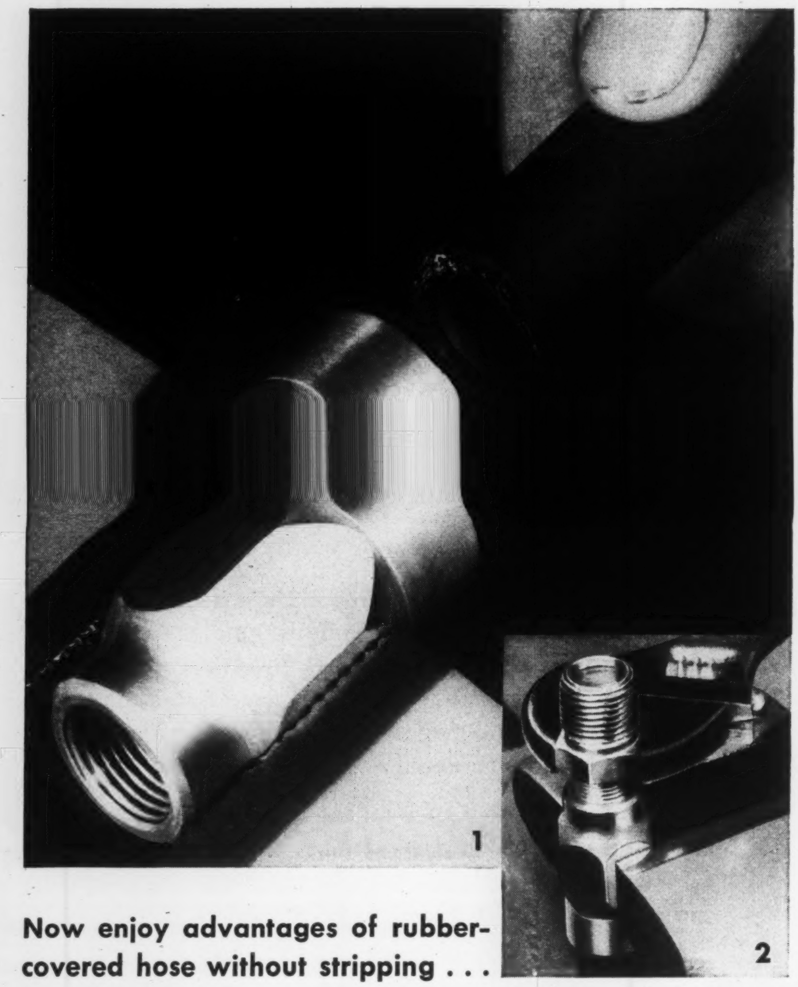

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Use new Parker NO-SKIVE fittings

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During step (1), the lead thread of the socket cuts through the rubber cover of the hose. This permits the threads following it to contact and grip the wire braid. It will hold beyond hose-bursting pressures . . . also under severe vibration conditions.

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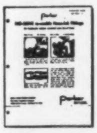

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—ITEM 662—

larity, controls and accessories, stresses and materials, general performance and installation.

◆

The Design of Switching Circuits. *By William Keister, Alistair E. Ritchie and Seth H. Washburn; 576 pages, 6¼ by 9¼ in., clothbound; published by D. Van Nostrand Co. Inc.; available from* MACHINE DESIGN, *$8.00 postpaid.*

This book presents the fundamental principles in the design of switching circuits. Particular installations are not emphasized, but specific circuits serve as examples. Chapters cover an introduction to the subject, physical and electrical characteristics of switching devices, design fundamentals of switching circuits, aggregates of switching devices, and methods of synthesizing working systems.

New Standards

Slotted and Recessed Head Wood Screws, ASA B18.6.1-1956. 15 *pages, 8½ by 11 in., paperbound; published by and available from the American Society of Mechanical Engineers,* 29 *West 39th St., New York* 18, *N. Y.;* $1.00 *per copy.*

This standard for wood screws had been part of the American Standard for Slotted and Recessed Head Screws, dated 1947. Now it is published separately as are other sections of the same standard for other kinds of screws. Of the few changes in this revision, one is the addition of penetration gaging for recessed head screws.

◆

1955 Book of ASTM Standards. 6 *by* 9 *in., clothbound; published by and available from the American Society for Testing Materials,* 1916 *Race St., Philadelphia* 3, *Pa.;* $84.00 *per set, vol.* 1 *to* 7.

ASTM Books of Standards are published in seven volumes every three years. This issue succeeds that of 1952. The books contain

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—ITEM 664—
For More Information Circle Item Number on Yellow Card—page 19

standard and tentative specifications and methods of test for most engineering materials. Publication of Part 1 for 1955 was announced earlier this year. The balance of the set is now available. Titles and unit prices are:

Part 1—**Ferrous Metals**, 315 standards, 1834 pages, $13.50
Part 2—**Non-Ferrous Metals**, 270 standards. 1516 pages, $11.00
Part 3—**Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing and Soils**, 477 standards. 2062 pages, $13.50
Part 4—**Paint, Naval Stores, Wood Cellulose, Wax Polishes, Sandwich and Building Constructions, Fire Tests**, 323 standards, 1416 pages, $11.00
Part 5—**Fuels, Petroleum, Aromatic Hydrocarbons, and Engine Antifreezes**, 242 standards, 1496 pages, $11.00
Part 6—**Electrical Insulation, Electronic Materials, Plastics and Rubber**, 300 standards, 1776 pages, $13.00
Part 7—**Textiles, Soap, Water, Paper, Adhesives, and Shipping Containers**, 354 standards. 1692 pages. $11.00

Association Publications

Powder Metallurgy—Now. *By F. V. Lenel; 34 pages, 6 by 9 in., paperbound; published by and available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; $1.50 per copy.*

This booklet concerns mechanical properties of parts made from metal powders, certain recent techniques for making semifabricated products from powder, and possible uses of powder metallurgy products for high strength at high temperatures. Major headings in the text are: High-strength structural parts, aluminum powder metallurgy, pellet extrusion of magnesium alloys, beryllium powder metallurgy, powder rolling, cermets, and transpiration-cooled materials.

•

ASME Handbook: Engineering Tables. *Edited by Jesse Huckert, professor of Mechanical Engineering, Ohio State University; 704 pages, 7 by 9¾ inches, clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$12.00 postpaid.*

This reference book is one of four volumes in the ASME series. It is intended particularly for de-

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AMERICAN WELDING

—ITEM 665—

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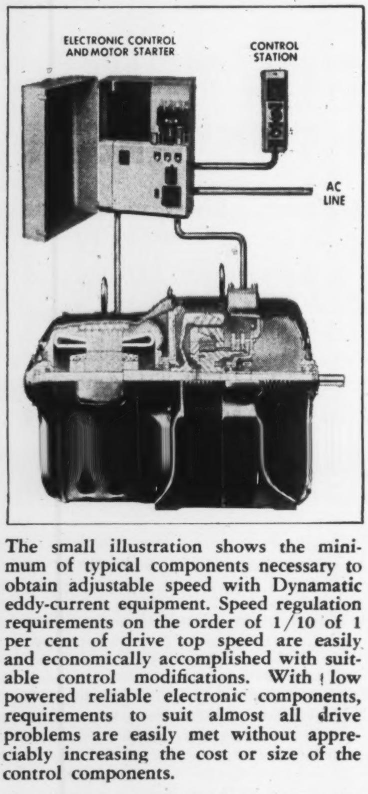
DYNAMATIC® ELECTRONIC CONTROLS

Can Solve Your Adjustable Speed Problems

Dynamatic electronic controls with their simplicity, low maintenance, easy accessibility, and small space requirements, when used with Dynamatic Eddy-Current Drives, provide the solution to most adjustable speed drive problems.

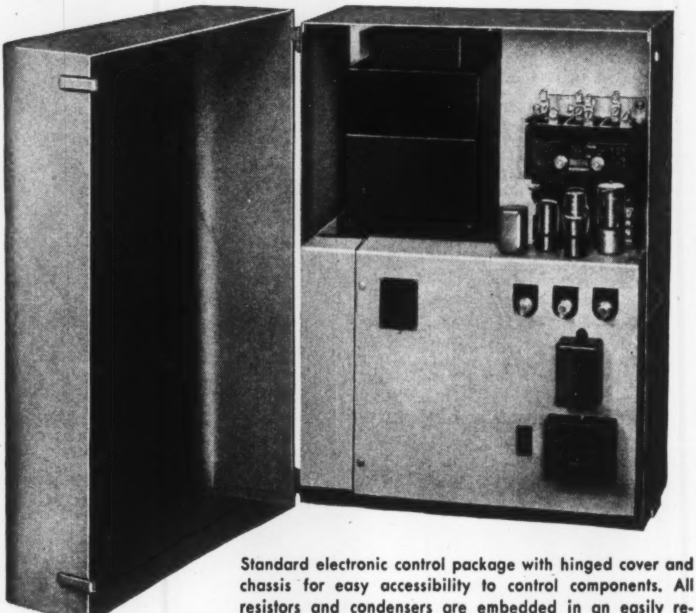
The excitation required by Dynamatic eddy-current equipment is of very small magnitude compared to the drive capacity. For example, a 440 watt control is capable of controlling the torque or speed output of a 400 HP drive. Control and excitation power is taken directly from AC lines without the need of cumbersome and complicated convertors, with their installation, ventilation, and maintenance problems.

Since the control elements have a very high amplification factor, even the largest couplings may be easily and conveniently controlled with small adjusting potentiometers.



The small illustration shows the minimum of typical components necessary to obtain adjustable speed with Dynamatic eddy-current equipment. Speed regulation requirements on the order of 1/10 of 1 per cent of drive top speed are easily and economically accomplished with suitable control modifications. With low powered reliable electronic components, requirements to suit almost all drive problems are easily met without appreciably increasing the cost or size of the control components.

The following outline of operation will indicate the many advantages of this Dynamatic control equipment.



Standard electronic control package with hinged cover and chassis for easy accessibility to control components. All resistors and condensers are embedded in an easily replaced assembly. The drive motor starter can also mount in the control enclosure, which measures 25" x 19" x 14".

Direct current excitation applied to the Dynamatic Drive coil modulates the strength of the magnetic fields and consequently, the amount of torque developed at any rate of slip between the rotating input and output members. So that the drive may satisfy load and speed demands, this direct current must be varied automatically.

Because of the drive's small power demands, rectification of easily available alternating current to direct current is a simple procedure. A gas-filled thyratron tube is all that is needed to accomplish the conversion from AC to DC. A rectifier used in conjunction with the thyratron tube, plus the highly inductive eddy-current drive coil, provides a smooth flow of direct current as required by the drive.

To obtain desired performance, a means of varying the amount of current to the drive coil must be provided. The thyratron tube provides this function in that the grid of the tube, influenced by an AC rider wave imposed upon the DC grid voltage, permits a smooth change in drive coil voltage from zero up to the available maximum.

A permanent magnet alternator, driven by the output shaft of the Dynamatic Drive, generates a voltage in direct proportion to speed. This voltage directed to the electronic control is utilized to maintain pre-set speed. With a reduction in load, speed tends to increase, but the generator signals the control so that the drive coil current decreases, slowing down the unit. Conversely, should the load increase, the drive tends to slow down so that the generator signal to the electronic control automatically increases the current, permitting the drive to return to the pre-set speed.

Speed and load (current) control are two of the standard types of electronic controls available. Because of the almost unlimited uses and adaptations of electronic components, many operations can be conveniently controlled, such as tension, acceleration, braking, threading, jogging, speed matching, and many others where an electrical signal can be fed to the control equipment.

Send for our 16-page Illustrated Bulletin on Electronic Controls

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—ITEM 666—

signers and contains many tables of recognized design standards not widely published. Contents of the book are arranged in 15 sections, grouping together tables which apply to the design of specific parts. Representative of subjects covered are bar stock and shafting; bearings; spur, helical and herringbone, bevel, and worm gears; cylindrical fits; keys and keyseating; bolts; springs; aircraft and mechanical tubing; serrations and splines; electric motors, and gaskets.

Government Publications

Investigation and Development of High-Temperature Structural Adhesives, WADC Technical Report 54-98. *By H. N. Homeyer Jr., J. H. Preston and K. L. McHugh;* 112 *pages,* 8¼ *by* 10¾ *in., paperbound; published by Wright Aeronautical Development Center; available from Office of Technical Services, U. S. Dept. of Commerce, Washington* 25*, D. C.;* $3.00 *per copy.*

This report describes work on the investigation and development of structural adhesives from silicone materials for high-temperature service such as encountered in aircraft. Results are reported on lapshear tests on aluminum-to-aluminum specimens bonded with silicone resins, rubbers, copolymers, and certain experimental mixtures.

◆

NACA Technical Series. *Each publication is* 8 *by* 10½ *inches, paperbound, side-stapled; copies available from National Advisory Committee for Aeronautics,* 1924 *F St. N.W., Washington* 25*, D. C.*

The following Technical Notes are available:

3598. **Method and Tables for Determining the Time Response to a Unit Impulse from Frequency-Response Data and for Determining the Fourier Transform of a Function of Time**—38 pages.

3600. **Correlation of Crippling Strength of Plate Structures with Material Properties**—50 pages.

3631. **Results of Axial-Load Fatigue Tests on Electropolished 2024-T3 and 7075-T6 Aluminum-Alloy-Sheet Specimens with Central Holes**—47 pages.

3646. **A Theory for the Elastic Deflections of Plates Integrally Stiffened on One Side**—21 pages.

3655. **Method of Calculating Core Dimensions of Crossflow Exchanger with Prescribed Gas Flows and Inlet and Exit States**—25 pages

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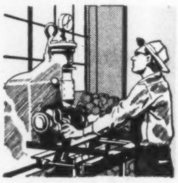
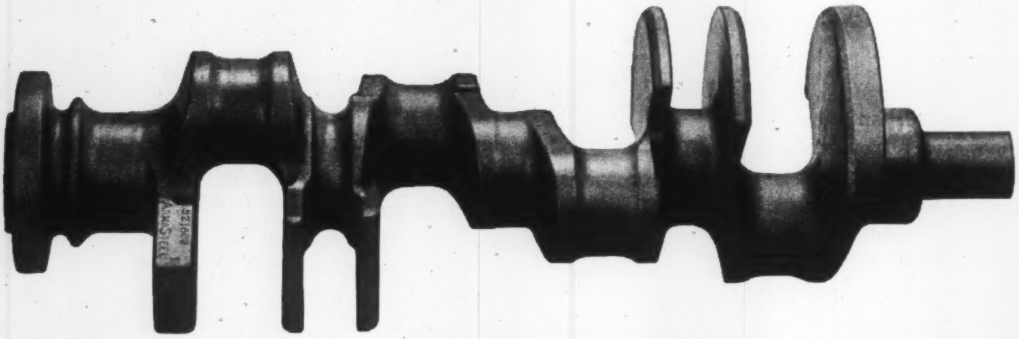
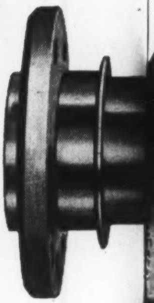
—ITEM 667—

the step-by-step story of how ARMASTEEL shell-cast crankshafts saved machine time, tools, and labor for Pontiac Motor Division

After hundreds of hours of research and experimentation, the Pontiac Motor Division in 1955 began installing *cast* crankshafts in their automobiles, and in 1956 have completed a 100% conversion to castings. It was because of the combination of Central Foundry Division's amazing material, ARMASTEEL, combined with the new shell mold process that made this switch-over to cast crankshafts practical and profitable.







ARMASTEEL, a pearlitic malleable iron made only by Central Foundry Division, provided the extreme toughness, rigidity, damping qualities and all the other physical properties necessary for better crankshafts. And the superior machining characteristics of ARMASTEEL plus the close dimensional tolerances of the shell mold process made possible the substantial savings from one end to the other of the crankshaft finishing line. Take it step by step . . .

1

THE FIRST STEP IN MACHINING cast crankshafts at Pontiac is the milling of the driving pads. Where formerly they processed 80 steel crankshafts an hour on these milling machines, production has now been increased to 96 an hour on the ArmaSteel parts. A similar increase has been noted in tool life . . . during a two-week period of machining steel crankshafts, 336 cutters had to be ground, while in a two-week period when the crankshafts were ArmaSteel, only 153 cutters needed grinding.

2

SECOND STEP IN THE PROCESS is the turning of all in-line diameters on crankshaft lathes. Here, it was found that the superior machineability of the ArmaSteel parts allowed lathe speed to be increased from 53 R.P.M. to 153 R.P.M., and that the rack-to-rack cycle time reduced from 2.75—3.00 minutes to 1.40—1.50 minutes, thus doubling output.

3

THIRD STEP is the rough grinding of main journals. Where steel forgings were ground at the rate of 32.5 per hour, 45 ArmaSteel cast crankshafts are being processed per hour. Grinding wheel life is substantially increased.

4

FOURTH STEP involves the rough turning of crankpins. Production has been speeded here from 24 steel parts to 46 ArmaSteel parts per hour, due partly to decreased stock to be machined.

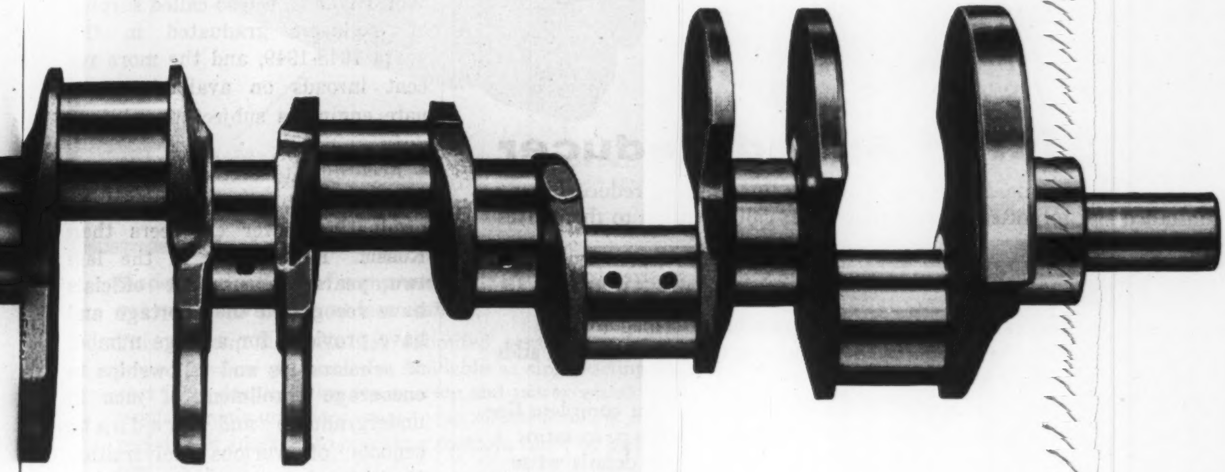
5

FIFTH STEP is finish turning on the crankpins. Production has been more than doubled on this operation. Where 21 steel crankshafts per hour were processed, 46 of ArmaSteel are being turned.

6

THE REMAINING OPERATIONS INCLUDE oil-hole drilling, finish grinding on main journals, straightening, and tapping of holes in the flywheel flange. In drilling oil holes, production men found that the need for retracting drills periodically for chip removal was eliminated by ArmaSteel. This helped speed output from 37.5 steel to 64 ArmaSteel parts per hour. Drills needing to be reground or replaced were only about ¼ as many with the cast crankshafts. One transfer drilling line has been discontinued, which allowed the elimination also of one lathe for turning OD of counterweights, and one straightening press, both of which were automated with the drill. Less straightening is necessary on the ArmaSteel castings, and finish grinding on main journals is faster than with steel. A greatly reduced number of taps are used in tapping the flywheel flange holes.

THUS, MACHINE TIME, TOOLS, LABOR, and long-range capitalization have all been decreased through the change to shell-cast ArmaSteel crankshafts. Performance of the part is excellent, and many new design possibilities have been opened up. This is likewise true of many other products that have taken advantage of ArmaSteel and Central Foundry Division's shell mold process. For information on how your product can also benefit, write today for your copy of the "ARMASTEEL" catalog and pamphlet "Shell Molding at Central Foundry".



CENTRAL FOUNDRY DIVISION • GENERAL MOTORS CORPORATION

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 14

—ITEM 668—
For More Information Circle Item Number on Yellow Card—page 19

WINSMITH
Speed Reducer
MODEL
SERIAL
OUTPUT TORQUE
RATIO
SERVICE FACTOR
INPUT R.P.M.
DATE
INPUT H.P.
WINSMITH, INC.

INSTALL IT

FORGET IT!

. . . when it's a

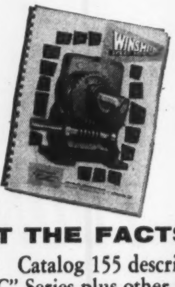
WINSMITH Speed Reducer

Get acquainted with the Winsmith line of speed reducers that are installed and forgotten because they never call attention to themselves as trouble-makers.

Next time you want to cut your r.p.m's. down to size accurately, under the most rugged operating conditions, specify Winsmith . . . the line of speed reducers that can be described in just one word — *dependable!* You'll find that their performance adds to the reputation of your equipment.

And, as a source of supply, Winsmith offers the most complete line of reducers within the range of 1/100 h.p. to 85 h.p. in ratios of 1.1:1 to 50,000:1. For complete details write for Catalog 155, described below.

WINSMITH
SPEED REDUCERS



GET THE FACTS!
Catalog 155 describes the *new* "C" Series plus other units in the Winsmith line. Contains complete selection information for each model described.

WINSMITH, INC. 16 Elton Street, Springville, (Erie County), N. Y.

—ITEM 669—
For More Information Circle Item Number on Yellow Card—page 19

Professional Viewpoint

MUCH discussion about the shortage of engineers has occurred. Predictions have been made that the shortage will continue and actually grow worse during the next five years. Here, by George R. Northrup, Ohio University, is a suggested way in which the shortage can be combatted to some extent.

A Step Toward Relieving the Shortage of Engineers

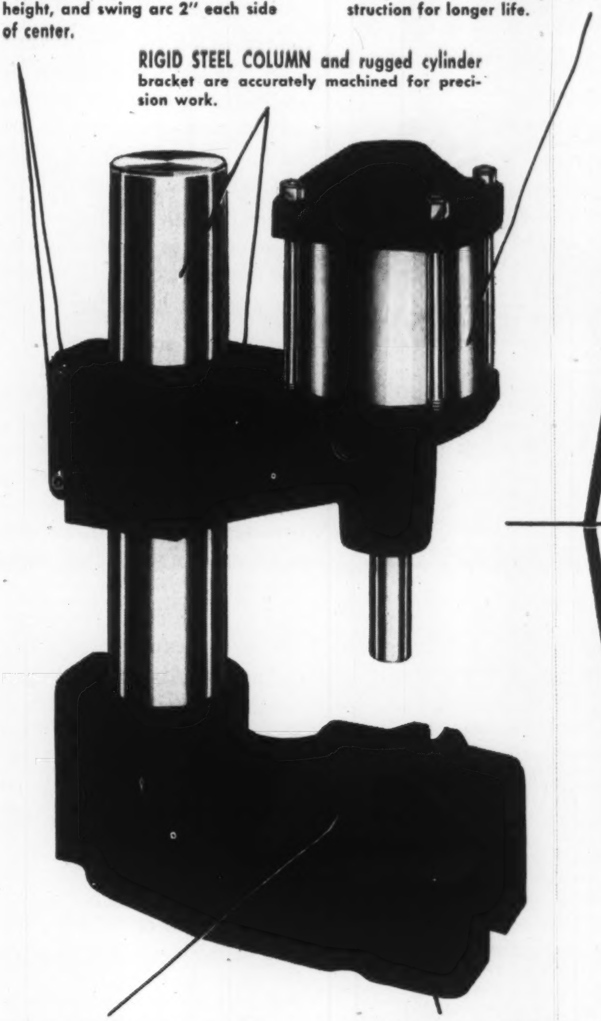
The chief reason for the shortage of engineers is the technological progress during and following World War II. The demand for engineers has simply been greater than the supply. Other factors have contributed to this shortage: The low enrollment in engineering colleges immediately preceding World War II, the so-called surplus of engineers graduated in the years 1948-1949, and the more recent inroads on available graduate engineers subject to military duty.

According to recent articles, the United States may at present be graduating fewer engineers than Russia. Particularly in the last two years, government officials have recognized the shortage and have provided for a large number of scholarships and fellowships to encourage enrollment of men in undergraduate and graduate schools of various universities. Various industries, as well, are encouraging technical studies under various programs.

Although such programs to provide a future pool of engineers are certainly steps in the right direction, they may not be the whole answer.

The Problem: A more immediate goal might be to gain the maximum utilization of the technical ability of the engineer.

Many companies overlook the importance of the work each en-


TWO-BOLT CLAMPING adjusts easily, positively from 0" to 7" in height, and swing arc 2" each side of center.
HEAVY-DUTY CYLINDER with extra heavy wall, tie rods and piston construction for longer life.
RIGID STEEL COLUMN and rugged cylinder bracket are accurately machined for precision work.
HEAVY, RUGGED BASE forms sturdy foundation for large machined-surface table area.
SPECIAL RECESS IN TABLE provides for punch-through operations.

NEW SCHRADER AIR PRESS

It's compact and power packed!

It stamps, coins, broaches, rivets, stakes, presses, shapes, bends, assembles—*many other uses!*

Modern "muscles" of compressed air never tire . . . get more work done at less cost!

This modern Air Press has unlimited possibilities for speed, power, positive performance. Available as single acting for impact jobs; double acting for squeeze and power withdrawals. It requires minimum space, next to no maintenance, is extremely versatile in adapting to operating controls. Can't be beat for low cost practicality.

Important feature: Control and speed of the extra heavy cylinder and ram can be varied as necessary, by using standard Schrader Air Control Accessories that adjust in seconds.

Write for Catalog data describing Air Press fully—including variety of controls, accessories and prices. You'll be surprised at the low prices!

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Division of Scovill Manufacturing Company, Incorporated
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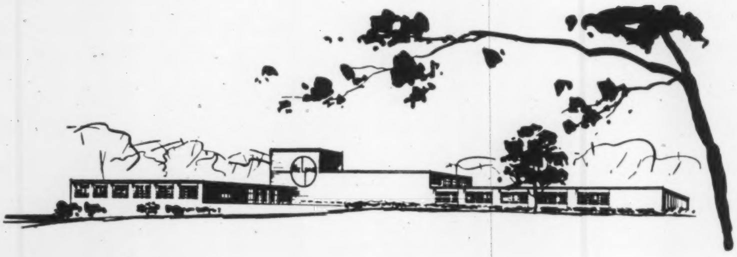
Schrader®
ESTABLISHED IN 1844

LEADERS IN AIR CONTROL SINCE 1844

—ITEM 670—
For More Information Circle Item Number on Yellow Card—page 19



ENGINEERS,
Electronic & Mechanical
PHYSICISTS:

Top Grade Openings
At Melpar *Leader in Electronic Research & Development*

Due to our continuing expansion program, a number of top grade openings exist in our new laboratories suburban to Washington, D. C. We urge you to consider the following:

1. At Melpar the engineer is not tied to a pre-arranged schedule of advancement. Instead, promotion and advancement are based on *individual recognition,* where skill and ability are the paramount factors of determination.

2. Melpar has doubled in size every 18 months for the past 10 years. New openings occur constantly. This enables the engineer to advance to positions of increased responsibility *as soon as he is ready.*

3. Our unique "project team" basis of organization gives the engineer an opportunity to participate in *entire* problems from conception to completion of prototype, and thus experience the "overall" approach to engineering problems necessary to eventual directorship responsibility.

4. Our new air-conditioned laboratories encompass over 285,000 square feet and offer *complete* facilities for creative research and design. In addition to our central Model Shop, supplementary facilities, personnel and test equipment are available for immediate use within each project group.

5. The Northern Virginia Area, suburban to Washington, D. C., in which Melpar is located, offers excellent living conditions, enjoys the Nation's highest per capita income, fine homes and schools. Recreational, cultural and educational facilities abound. Fully-accredited graduate courses are offered at the Melpar laboratories and at 5 universities in the Area.

Top Grade Openings Exist in These Fields:

Network Theory • Systems Evaluation • Microwave Technique • UHF, VHF, or SHF Receivers • Analog Computers • Magnetic Tape Handling • Digital Computers Radar and Countermeasures • Packaging Electronic Equipment • Pulse Circuitry • Microwave Filters • Flight Simulators • Servomechanisms • Subminiaturization • Electro-Mechanical Design • Small Mechanisms • Quality Control and Test Engineering

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Write: Technical Personnel Representative

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A Subsidiary of Westinghouse Air Brake Company
3064 Arlington Boulevard, Falls Church, Virginia
Positions also available at our laboratories in: Cambridge, Mass., 99 First St., Watertown, Mass., 11 Galen St.

—ITEM 671—
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gineer is performing whether or not he is a recent addition to the staff. Initial assignments of new engineers in some companies, as a matter of procedure, are basically routine and involve work generally falling into nonengineering categories. Many months later, and in some cases several years later, the engineer may still be performing work on his initial engineering assignment, such as routine curve plotting, routine drafting, writing routine test requests and shop orders, following parts through manufacturing departments, and countless other duties of this nature. Engineers performing such work are often permanently relegated (particularly when they do an outstanding job) to such an activity which is described to them as a temporary expediency.

The "creative" engineer, in particular, is irked when after a short period of time he is not conducting an evaluation from an empirical standpoint on a challenging problem whether or not he is a recent addition to the technical staff. When engineering management ignores or fails to recognize that many engineers insist on fully utilizing their technical training and to advance their professional status, certain detrimental effects on morale can't help but occur.

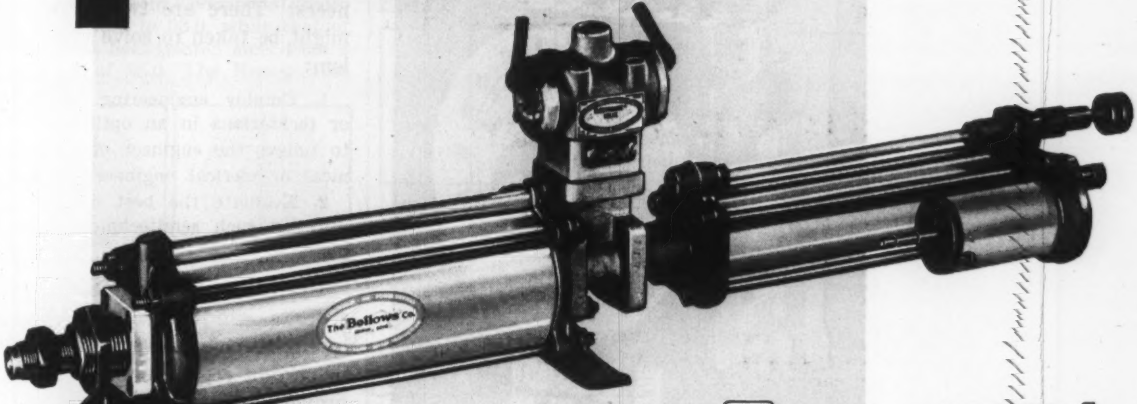
Here are the kinds of things that happen: Discussion among engineers about the lack of opportunity to use their special knowledge; an increasing reluctance among them to perform nontechnical duties; often, an inclination to look for greener pastures where challenging technical assignments exist; a not too unusual reluctance of particularly capable but "quiet" engineers performing routine work to resign for reasons that don't seem to tell the whole story.

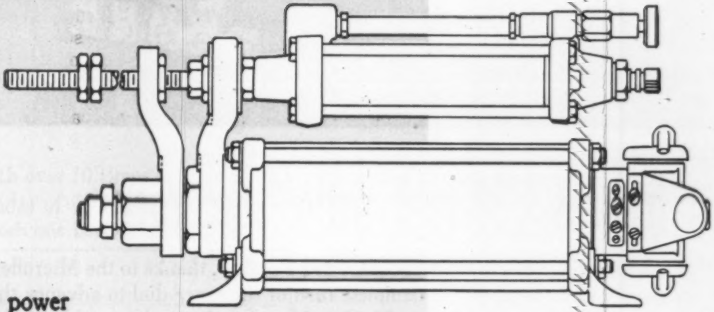
Any of these consequences is a blow to morale when word gets around, thus affecting development programs as well as output of the engineering department.

While engineers recognize that a certain amount of routine or nonengineering work is necessary in any engineering organization, they have a natural preference to

This AIR CYLINDER features—

1 **BUILT-IN *HYDRAULIC CONTROL***
2 **BUILT-IN *ELECTRIC CONTROL***
3 **BUILT-IN *SPEED CONTROLS***





In one compact packaged power unit are built-in controls to cover every phase of air cylinder operation. Built-in hydraulic control of piston rod movement gives the smoothness characteristic of hydraulic operation, yet retains the speed and flexibility of air power. Built-in electrically controlled directional valve permits quick, positive, push button remote control, or easy electrical synchronization with other machine elements. Built-in speed controls permit exact control of piston rod speed in either or both directions.

This combination of Bellows Air Motor and Hydro-Check is available in five bore sizes: 1¼", 1¾", 2½", 3⅝" and 4½" in standard stroke lengths up to 18".

Here is air cylinder power at its best—fast, flexible, safe, and smooth.

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DEPT. MD556

TWO MOUNTING STYLES

The Bellows Air Motor and Hydro-Check (Model HCB-EM) is available arranged in tandem as shown above, or in parallel, as sketched.

•

Combination units of Air Motor and Hydro-Check are also made with any one of six other Bellows directional valve arrangements; and, of course, Air Motors and Hydro-Checks are available as separate units.

The Bellows Co.

AKRON 9, OHIO

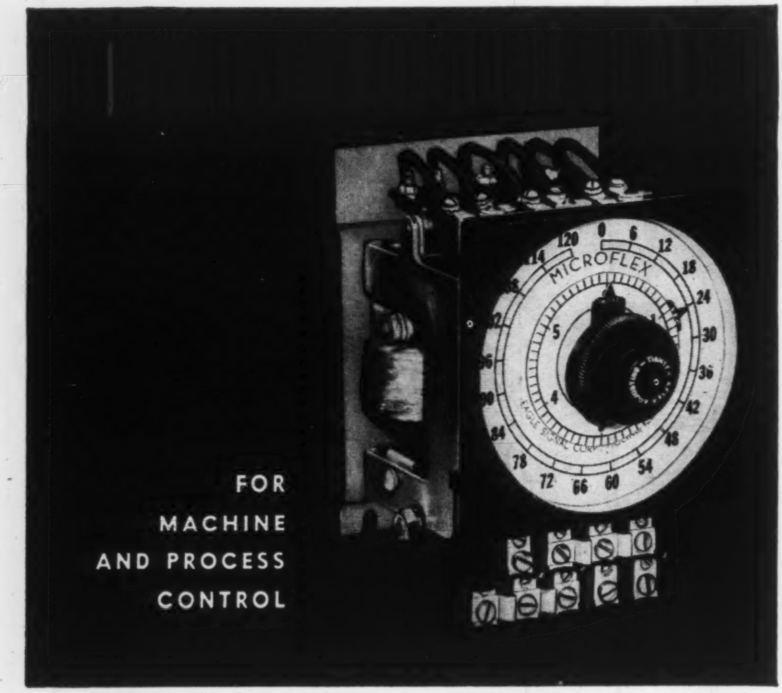
Controlled Air-Power

FOR FASTER, SAFER, BETTER PRODUCTION

1381-A

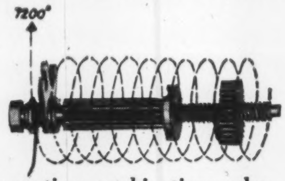
—ITEM 672—
For More Information Circle Item Number on Yellow Card—page 19

EAGLE
Microflex Reset Timer



Insures "20-to-1 ratio" accuracy

Time settings of pinpoint accuracy are a reality, thanks to the Microflex double dial. It takes one complete turn of the *inner* dial to advance the *outer* dial just one division. That's a 20-to-1 ratio, made possible by the patented Microflex threaded axle and pinion (see sketch). Examples of resultant accuracies are ± 1/60 of a second on a 20-second dial, and ± 1/10 of a second on a 120-second dial.



The Microflex Reset Timer is driven by a heavy-duty industrial synchronous motor. Contacts are tripped closed or open after a preset time interval. Starting and resetting are electrically controlled. Microflex offers over 150 timer operating combinations, plus a wide range of long or short time periods. It's ideal for applications like molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for free Automation Booklet and Bulletin 110.

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EAGLE

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. MD-556
MOLINE, ILLINOIS

Please send free Automation Booklet and Bulletin 110 containing complete data on Microflex Reset Timers.

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COMPANY
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—ITEM 673—
For More Information Circle Item Number on Yellow Card—page 19

spend more and more time on "engineering work." If engineering management recognizes this fact, and as a larger number of creative engineers spend more time on fundamental investigations and in creative design and analysis, greater engineering accomplishments can be obtained.

Effective Utilization of Engineers: There are two steps that might be taken to solve this problem:

1. Employ engineering assistants or technicians in an optimum ratio to relieve the engineer of semitechnical or clerical engineering duties.
2. Evaluate the best methods of utilizing such semitechnical personnel.

Utilization of engineering assistants will reduce the number of engineers to be recruited, result in certain economies, and tend to provide a more professional working atmosphere among the engineers. Such personnel can perhaps be upgraded from within the organization or recruited through local newsaper advertisements at costs ranging to $50.00 per man. Surveys among several large corporations have indicated that the cost per engineer recruited during the past two years has ranged between $1200 and $2000 per man, not including the salary cost of engineering supervisors on recruiting trips.

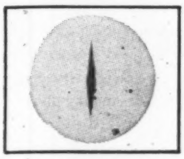
An evaluation of the day-to-day engineering problems and a segregation of the engineering portion of such problems to the engineer can result in the more efficient use of his technical training, improve his professional status, and increase creative ability.

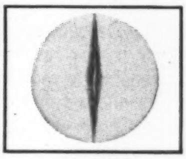
But, here's the next question to be answered: What portion of the work should be assigned to the engineer and to the engineering assistant?

Conducting the Evaluation: While the determination of what work should be performed by nontechnical personnel may seem to be a minor problem, one factor in particular may warrant more than casual consideration: Who should

A composition that is almost twice as hard as the hardest steel . . . KENNAMETAL*

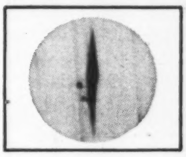
Kennametal is the registered trademark of a series of hard alloys of tungsten, tungsten-titanium, and tantalum carbides. These compositions are the *hardest* practicable metals made by man. In scratch hardness tests, these hard carbide particles are between sapphire and diamond. On the Rockwell "A" Scale, different Kennametal grades test from 90.0 to 93.0, while that of HSS 18-4-1 heat-treated steel tests a maximum of 85.0. The Knoop Test gives 2100 (K100) for Kennametal and 800 (K100) for steel.

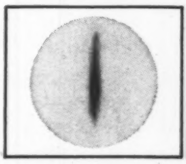

K8 Tungsten carbide

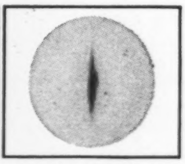

18-4-2 Steel

Photomicrographs above show results of Knoop hardness test on Kennametal K8 (left) and HSS 18-4-2 steel (right) at 100g. Impression in the Kennametal is only about half of that on the steel.

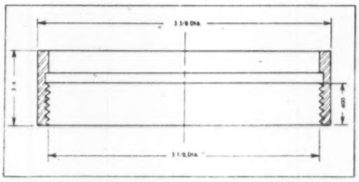
Photomicrographs below are of Knoop tests on grains of carbide ingredient of Kennametal. Knoop test numbers (at 100g) are: tungsten carbide, 1900; tungsten-titanium carbide, 2200; titanium carbide, 2500. These tests show those carbides are from two to three times as hard as steel in the absolute scale of Kgs per square mm of area of impression.


Tungsten carbide


Tungsten-titanium carbide

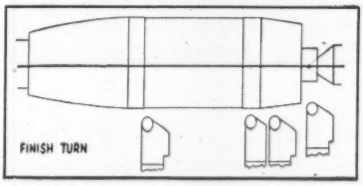

Titanium carbide

Extreme Hardness of KENNAMETAL Utilized by Designers



A West Coast manufacturer switched to solid Kennametal tungsten-titanium carbide tools for internal threading of stainless steel rings, jumped production from 35 to 40 pieces between grinds to 80 to 100 pieces with Kennametal. And the latter showed no cratering and only slight edge wear requiring only light grinding.

A manufacturer of aircraft landing gears uses the hardest grade of Kennametal cutting edges for interrupted cutting of SAE-4340 steel (220,000 psi tensile strength), at 1½ times greater speeds and with over 10 times longer tool life. Both sides of 54 pieces are rough cut and finish cut between grindings.



2400 to 3600 (depending on shell hardness) 90 mm shells are finished-turned using the hardest grade Kennametal before regrinding is required.

Perhaps KENNAMETAL's Extreme Hardness Can Help You, Too

Together with absolute hardness goes surprisingly greater resistance to wear and deformation. It is vital to innumerable industrial applications. Perhaps it is the characteristic you need to get YOUR idea off the drawing board and into production. It is worth investigating. Write to KENNAMETAL INC., Latrobe, Pennsylvania, and ask for Booklet B-111.

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Booth 313
at the Design Engineering Exposition

MAY 14-17
Convention Hall
Philadelphia, Pa.

Come in and visit us while you are in Philadelphia. See "live" demonstrations that prove the many outstanding characteristics of Kennametal and Kentanium (the titanium carbide for application at 1800° F and above). See such demonstrations as:

- The Torque Test
- The Hardness Test
- The Deflection Test
- The Vibration and Chatter Tests

Inspect dozens of sample machine and processing equipment parts made from Kennametal and Kentanium . . . typical applications being used in practically every industry. Our engineers will be glad to talk over any of your problems and advise how you may use these hard, strong metals to advantage.

B-5926

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KENNAMETAL
. . . Partners in Progress

—ITEM 674—
For More Information Circle Item Number on Yellow Card—page 19

"From 1/3 to 1/2 of all the energy produced in the world is consumed in friction."

This new book shows how to reduce wear and power loss.

(1)

THEORY AND PRACTICE OF LUBRICATION FOR ENGINEERS

By D. D. FULLER
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The first complete treatment of the subject, the work balances theory and practice. It presents an exceptionally complete treatment of the hydrodynamic theory, its development and applications. Current practice serves to illustrate the theories discussed. Numerous examples are worked out dealing with practical problems. Designs are included for a wide variety of bearings such as: machine tools, synchronous condensers, turbines, generators, centrifuges, thrust bearings, high speed bearings, etc.—and for bearings made of all materials from soft rubber and wood to ceramics and glass.

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The Complete Guide

(3)

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—ITEM 675—

Professional Viewpoint

analyze the nontechnical work of research, development and engineering groups?

Even though technical supervisors in engineering departments are in the best position to do this work, they rarely have time available to devote to matters which may seem to be less pressing than current engineering problems. In rare cases such supervision may also be reluctant to recognize the need for, or desirability of, engineering assistants.

When the technical supervisor cannot devote sufficient time to the problem, a second approach would be to have the staff administrative engineer, or equivalent personnel who know the technical organization, conduct the evaluation.

Duties which could be segregated to nonengineers include keeping records; preparing standard specifications, purchase orders, changes in design, test requests, and manufacturing shop orders; expediting; performing routine drafting, routine calculations, and curve plotting; recording test data; following minor tests; and assisting the engineers in other matters.

After the evaluation has been completed and the necessary proposals have been made to engineering management, steps can be taken by the engineering staff to assign duties of this type to engineering assistants.

Assuming that neither of these two programs would be feasible, the third alternative would be to employ a consulting organization to conduct the evaluation and submit a recommendation of procedure and objectives to management.

It is most important in conducting any analysis to recognize that it may be quite difficult to completely segregate "engineering" duties from other functions. In addition, personalities involved should not influence the final determination of separation of functions.

A continuing critical appraisal of the use of engineers will benefit both the engineers and their companies.

The Value of RELIABLE DELIVERIES

B C Elam

PRODUCTION MGR., THE CINCINNATI GEAR CO.

Any job involving a large amount of responsibility is exacting. While I do not claim that mine is the toughest, I can say that the rigid policy set down by our management requires constant diligence and effort.

It is the policy of The Cincinnati Gear Company to make a delivery promise to the customer that there is every reason to expect will be fulfilled. The customer has a right to receive accurate information concerning the anticipated shipment of his order, and he also has a right to expect that promise to be fulfilled. It is the job of my department to operate our *new production scheduling system* in such a manner that accurate delivery promises can be given, and at the same time prevent the lead time from being ridiculously long. It is gratifying to state that we have failed to meet schedules only in a very limited number of instances, and many times have been successful in helping customers who, for some reason or another, found themselves in a real jam.

The management of The Cincinnati Gear Company has charged me with the responsibility for deliveries. I know there will be no compromise short of the best possible job, and I can assure you that the most meticulous plannning is done to be certain that delivery promises will be met.

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO
"Gears—Good Gears Only"

CINTI

—ITEM 676—

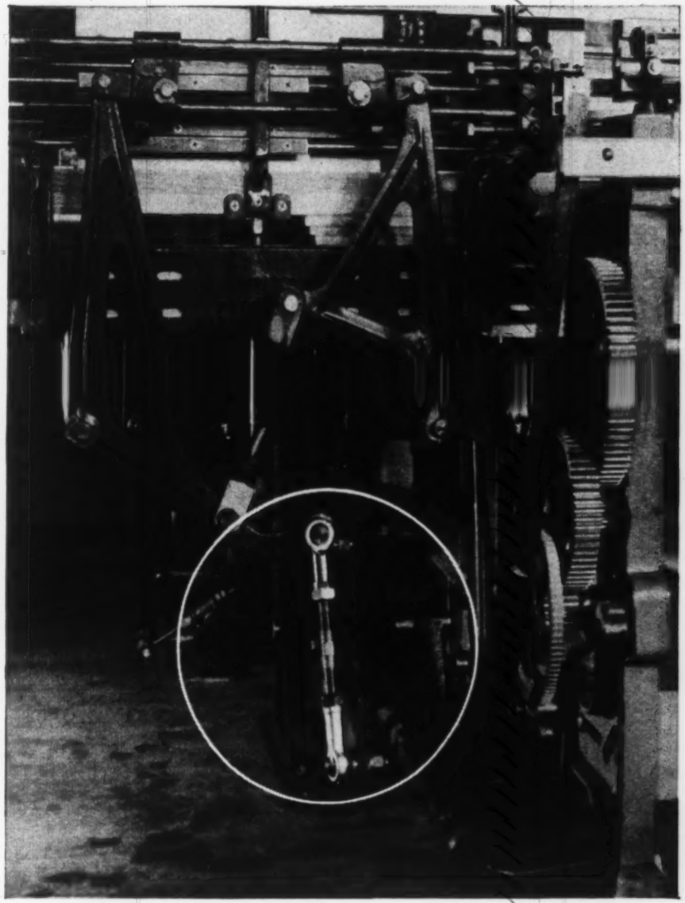
Heim *Unibal*

spherical bearing rod ends

One important feature of the Heim Unibal Spherical Bearing is its ability to correct shaft or linkage misalignment.

Very often, this feature of the Heim Rod End eliminates the necessity for costly precision machined components.

Brinelling is eliminated because of the area contact between the single ball and the bronze bearing member. Much greater load ratings are possible for substantially smaller dimensions.



Heim rod ends are a natural and have proven very satisfactory in the above application to the shuttle motion of a label loom as manufactured by Fletcher Works, Inc., Philadelphia.

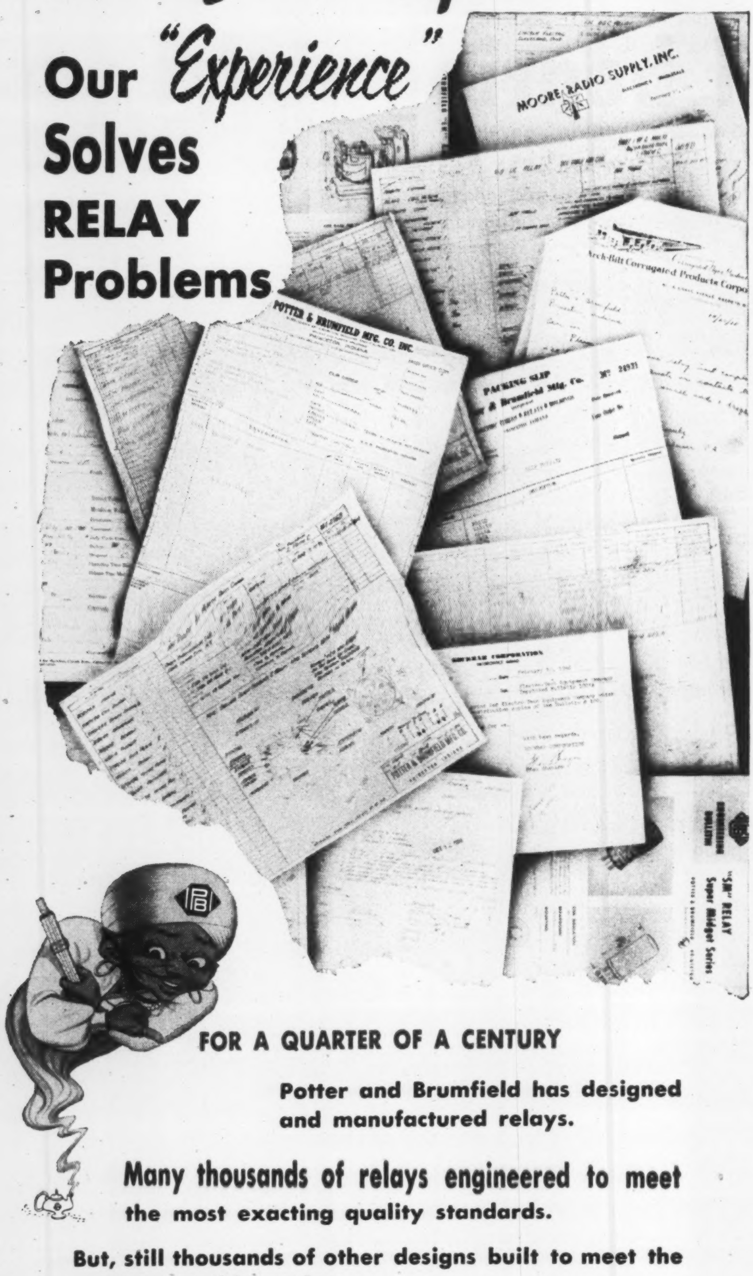
THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

Please write for comprehensive catalog or for any engineering data required.

—ITEM 677—
For More Information Circle Item Number on Yellow Card—page 19

"Nothing like Experience"

Our "Experience" Solves RELAY Problems



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Potter and Brumfield has designed and manufactured relays.

Many thousands of relays engineered to meet the most exacting quality standards.

But, still thousands of other designs built to meet the most competitive prices.

Samples and quotations gladly furnished.

For quick delivery over 350 different standard relays stocked by Franchised Distributors throughout the United States and Canada.

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PRINCETON, INDIANA
SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY COMPANY

RS Series Relay illustrated
low cost & sensitive type relay

—ITEM 678—
For More Information Circle Item Number on Yellow Card—page 19

New Machines

Air Conditioning

Dehumidifier: Portable dehumidifier mounted on four swivel casters controls moisture in closed areas up to 10,000 cu ft and removes up to 24 pt of water from the air every 24 hr. Air which is drawn into the bottom of the unit by a fan passes over a series of coils cooled to below room temperature. Moisture condenses and drops into a removable rustproof container. Drainage can be made fully automatic by connecting the hose to a drain. The unit operates on 110-115 v ac. It is 13½ in. wide and 20¼ in. high. Hermetically sealed 1/6-hp compressor requires no oiling. *Admiral Corp., Chicago.*

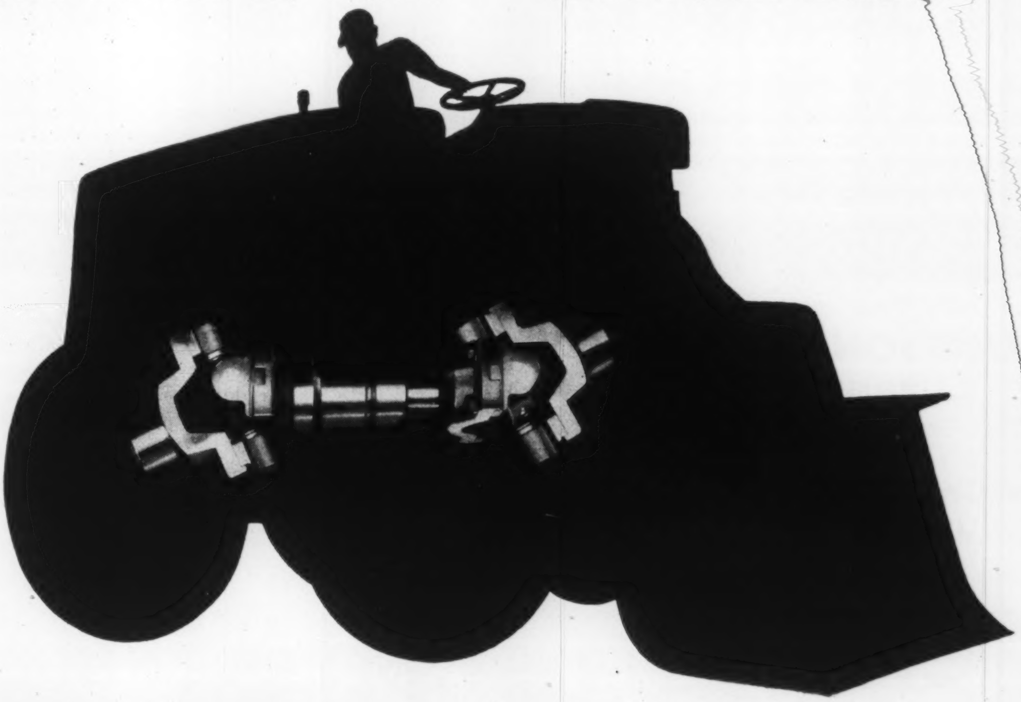
Roof Ventilator: LSQ power roof ventilator is available in five sizes in low and high-speed models. The ventilator is enclosed in an aluminum housing. Motor is a permanent split-capacitor type and has double-sealed, permanently lubricated ball bearings. Electrical connections are in the mounting saddle on the outside of the housing. Gravity and motor-operated shutters with interconnected blades to eliminate back draft are available as accessories. *Ilg Ventilating Co., Chicago.*

Materials Handling

Lift Truck: B-224 industrial truck with 2000-lb capacity has directional controls mounted on the steering column within reach of the operator's fingertips while both his hands remain on the steering wheel. Starting or reversing can be accomplished without using clutch or gearshift or removing either hand from the steering wheel. The truck incorporates automatic transmission, independent steering wheel suspension, and hydraulic equalizing rear suspension system which automatically compensates for floor variations up to 3 in. It turns within a radius of 67 in., is 40¼ in. wide and 67⅞ in. long, less forks. Powered by a 32-hp gasoline en-

VERSATILE

MECHANICS Roller Bearing UNIVERSAL JOINTS excell for both main drives and controls — in all kinds of material handling trucks. Have transmission flanges for any type of brake drum. Easy to service — MECHANICS Close-Coupled UNIVERSAL JOINTS transmit more power — in less space — at greater angles than any other joints. Let MECHANICS engineers help give *your* machines competitive advantages.



MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2032 Harrison Ave., Rockford, Ill.
Export Sales: Borg-Warner International
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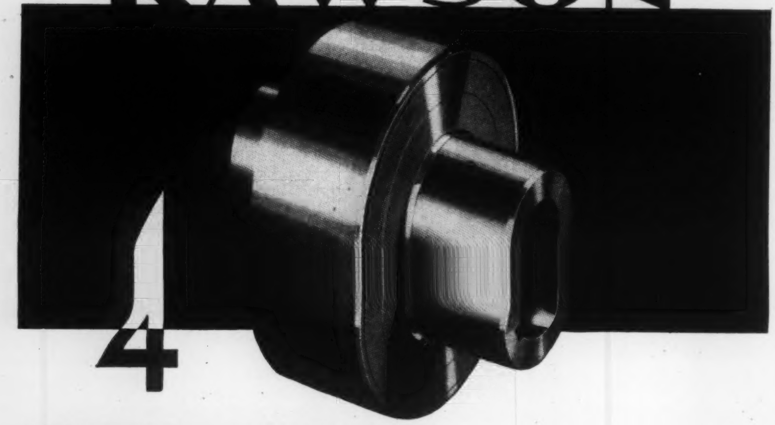
MECHANICS
Roller Bearing BW
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

—ITEM 679—
For More Information Circle Item Number on Yellow Card—page 19

RAWSON



4 PURPOSE COUPLING

Coupled to an engine drive, the spring controlled shoe permits the engine to idle at a predetermined speed. This feature is particularly valuable for warming up purpose . . . . wherever a machine is operated intermittently . . . . Allows the engine to idle without operating the machine . . . automatically picks up load whenever the engine speeds up and again releases at idling speed.

Starts . . . couples . . . cushions . . . limits load

RAWSON COUPLING DIVISION

O. S. WALKER CO., INC., Worcester, Massachusetts

—ITEM 680—

MECHANICAL ENGINEERS

with experience in design of:

- Precision Mechanisms
- Radar Antenna pedestals and mounts
- Lightweight Structural members.

OUR CUSTOMERS WANT EQUIPMENT, NOT SCHEMATICS!
FRAGILE
RADAR-AN/SP

The recent expansion of our engineering facilities makes it possible to offer unusual opportunities to experienced creative engineers.

Beginning salary range: $6000 to $10,000.

A brief resume form and a brochure describing our new laboratory may be obtained by writing to Mr. Robert E. Doherty.

At Raytheon's new Wayland Laboratory Mechanical and Electrical engineers work together as a team to create the custom designed equipment which has enhanced Raytheon's reputation for "Excellence in Electronics".

RAYTHEON MANUFACTURING COMPANY

WAYLAND LABORATORY WAYLAND, MASS.

RAYTHEON

- Full tuition paid for accepted educational programs.
- Location convenient for country or city living.
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—ITEM 681—

gine, the truck operates at speeds up to 11.5 mph; lift speed loaded is 58 fpm. Double-acting hydraulic cylinders control tilt 3 deg forward and 10 deg back. *Lamson Mobilift Corp., Syracuse, N. Y.*

Bar Unloader: Automatic unit can unload pieces of bar or tubing from a production machine to a high tote box. Equipped with one stationary tower and one moveable elevator, it can be adjusted to handle pieces from 3 to 12 ft long and from 1½ to 3 in. in diam at a variable rate of speed. Power is furnished by a ½-hp, 220/440-v, three-phase motor operating through a square shaft which motivates both elevating conveyors. *Feedall Inc., Willoughby, O.*

Portable Lift: Model L1112-P telescoping lift is designed for high stacking operations; collapsed height is low enough for handling loads in areas with low head room. The machine has a 1000-lb capacity and battery-powered hydraulic lift. It can be used as platform truck, straddle fork truck, portable elevator and shop crane. Lift height range is from 2 to 112 in. Overall height is 78¼ in.; width, 37 in.; length, 52 in. Turning radius is 60 in. *Oster Mfg. Co., Cleveland.*

Metalworking

Wire Straighteners: Automatic machines straighten and cut wire of various sizes, shapes and materials to desired lengths. Various models handle wire with diameters from 1/16 to ¼-in.; from 1/16 to 5/16-in.; and from ⅛ to ½-in. Positive clutch and trip mechanism make possible handling of small-diameter wire. Electric operation with variable speed drive makes possible high rate of wire feed. Cut-off mechanism is automatically synchronized. Wire catcher pan is the full length of the machine and can be emptied without handling the cut lengths. *Geo. C. Patterson Machine Co., Cleveland.*

Tool Grinder: Poweramic off-hand single point carbide tool grinder produces microfinishes on standard and special single point tools such as square nose, V-nose, straight turning, lead angle, offset turning, facing and boring tools. Motor-spindle unit is oscillated me-

FX the mark of ingenuity

What's your Problem?

Fastex can help you find a cost-cutting answer to your specific mass-assembly component problem. Highly specialized production facilities and creative engineering are combined to help you realize maximum, immediate savings. Fastex specializes in the design and production of volume runs of simplified components, fastenings and multiple-part assemblies. For new approaches to improved mechanical or electrical action through plastic and metal parts, contact Fastex . . . now.

is it time...

is it space...

is it motion...

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FASTEX
SHAKEPROOF
DIVISIONS OF ILLINOIS TOOL WORKS
World's Broadest Line of Mass-Assembly Fastenings

195 Algonquin Road, Des Plaines, Illinois

In Canada: Canada Illinois Tools Limited, Toronto, Ontario

IF YOU HAVE FLUID LINES TO CONNECT
YOU'LL SAVE TIME AND TROUBLE WITH

HANSEN
QUICK-CONNECTIVE
COUPLINGS

HANSEN PUSH-TITE COUPLING
Shuts off one side of line

Gives quick connection and disconnection, with instant automatic flow or shut-off. To connect coupling, and open line to flow of fluid, merely push plug into socket. To disconnect, a slight pull on sleeve releases plug and shuts off supply end of line.

HANSEN HIGH PRESSURE TWO-WAY SHUT-OFF COUPLING

To connect, pull back sleeve and push plug into socket. Identical torpedo type valves permit free flow of gas or liquid through coupling. To disconnect, pull back sleeve . . . coupling immediately disconnects, valves automatically seal both ends of line. Can be mounted to disconnect automatically where fluid lines may be subject to sudden, damaging strain.

HANSEN STRAIGHT-THROUGH COUPLING

Provides quick connection and disconnection, but does not have shut-off feature. Size range for general use from ¼" to 2½". Two special types of straight-through steam couplings also available—one for low pressures, and one for high pressures.

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QUICK-CONNECTIVE
FLUID LINE COUPLINGS
for
AIR • OIL • GREASE
HYDRAULIC FLUIDS • WATER
VACUUM • STEAM • OXYGEN
ACETYLENE • REFRIGERANTS
GASOLINE • COOLANTS

WRITE FOR CATALOG

THE HANSEN h MANUFACTURING COMPANY
4031 WEST 150th STREET • CLEVELAND 11, OHIO

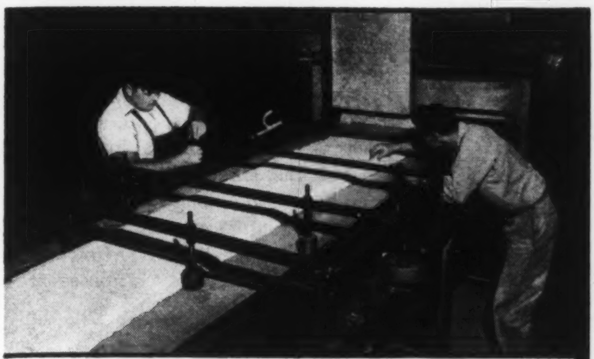
—ITEM 683—
For More Information Circle Item Number on Yellow Card—page 19

chanically by a motor-actuated crank mechanism at the rate of 150 strokes per minute to eliminate lateral tool movement. True angular settings of the work table from 7 deg above to 20 deg below horizontal are obtained by a crank mechanism and are registered on a visible protractor. Coolant is supplied by a self-contained pumping unit in the machine base. Spindle motor is 1 hp, 220 v. 60 cycles; spindle speed is 3450 rpm. Grinder dimensions are 28 x 28 x 48 in. *Wesson Co., Detroit.*

Abrasive Cutter: Cutamatic model 64 oscillating wet abrasive unit cuts sheets, angles, channels, pipes, tubes and solids of hardened or annealed steel, brass, bronze, monel metal, aluminum, magnesium, tungsten, ceramics, phenolic plastics and glass. Equipped with a large abrasive cutting wheel, it is capable of cutting 3-in. diam solids, 4-in. diam tubing and 6 x 1 in. steel plate at 90 deg to axis at speeds of 4 seconds per sq in. Swivel type vise, operated by a foot treadle, can be rotated from 0 to 45 deg with a maximum opening for 45-deg cuts of 4 in. Wheel and work are fed manually, and work clamps are operated by a foot treadle. Oscillating unit is powered by a 1/3-hp geared-head motor; abrasive cutting wheel is driven by a 10-hp, totally enclosed, fan-cooled motor. Drive from the motor to the spindle is through multiple V-belts. *American Chain & Cable Co. Inc., Bridgeport, Conn.*

Processing

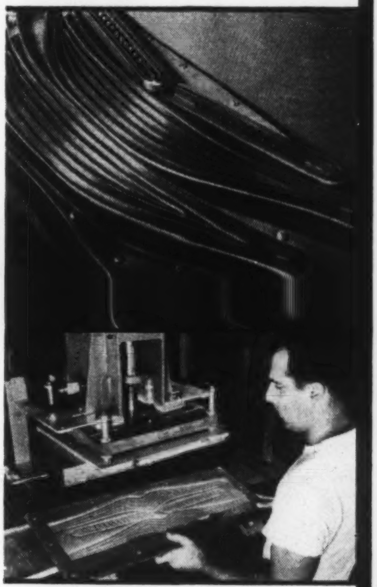
Hardening Machine: Induction type unit, rated at 30 kw, has a high frequency range from 1200 to 1400 kc which permits rapid surface hardening of parts requiring shallow case depth and narrow transition zones between case and core, as well as for small or thin-walled parts. Solid parts such as shafts up to 2 in. diam can be hardened; capacity for nonsolid parts depends upon their shape. Use of high frequencies prevents the formation of scale and reduces distortion. The machine consists of a power supply unit which can be remotely located, an oscillator unit and the work unit. A variable out-



doing unusual jobs unusually well for 20 years

Shown here is a production test run of new RUBATEX VINYL FOAM. Possesses all good qualities of foam cushioning PLUS . . . Resistance to tearing, aging and abrasion . . . Greater tensile strength than latex foam . . . Good compression but unlike rubber "no bounce" making it adaptable for packaging of electronic tubes and delicate precision instruments . . . Does not stain or discolor from contact with rubber chemicals, varnish, plastic materials, etc. . . . Outstanding flame resistance when desired—a property not found in other foam products.

All this at a price competitive to latex foam. Available in complete range of densities, firmnesses and matching colors. Produced in flat utility stock in sheets 2" thick x 36" wide. Write us for complete details.



Rubatex Vinyl Foam is a polyvinyl chloride compound with same heat sealing properties as unsupported vinyl film—making it an outstanding material for heat sealing applications. Shown here are belt dies indicating intricate stitching designs and air operated press with die attached to upper platen hooked to high frequency electronic generator. 2 belts can be heat sealed every 2½ seconds. Old stitching methods would take at least 15 minutes per belt.

Heat sealing of Rubatex Vinyl Foam gives luxurious look to products. Can be produced faster, cheaper for lower retail prices. Bulk of Rubatex Vinyl Foam now being used for such novelty items as shown here. Also adaptable for packaging, furniture and seating industries as well as many industrial applications.

G.A.I. RUBATEX

PIONEER MANUFACTURER OF CLOSED CELLULAR RUBBER

also manufacturers of:

Rubatex Closed Cellular Rubber
Rubatex Insulation Hardboard
Rubatex Closed Cellular Vinyl
Rubatex-Crepe
Rubatex Softee-Crepe
Rubatex Plastic Seine Floats

GREAT AMERICAN INDUSTRIES, INC.
RUBATEX DIVISION, Bedford, Virginia

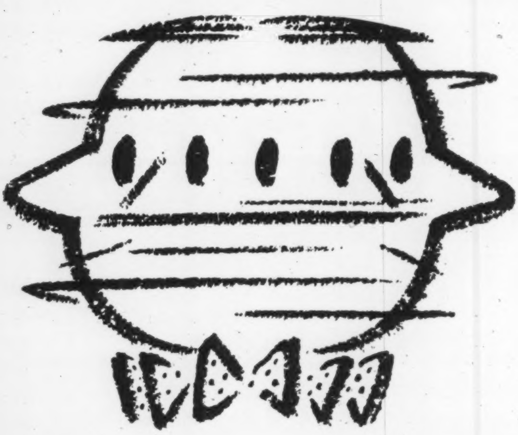
—ITEM 684—
For More Information Circle Item Number on Yellow Card—page 19

put transformer permits varying the heat input to a coil, so that it can be used for several low-production runs. Channel duct wiring facilitates the location of circuit trouble; lights permit visual location of damaged relays. *Cincinnati Milling Machine Co., Process Machinery Div., Cincinnati.*

Slicing Machine: MTA-1 Microtomatic machine slices and dices brittle, crystalline semiconductors such as germanium and silicon. It can also be used on piezoelectric crystals and for slicing test blanks from small, hardened steel or tungsten carbide tools. The unit employs a thin, circular diamond saw blade for slicing ingots. Work table, 6 x 18 in., feeds the ingots into the cutting wheel at rates as low as 1/16-in. per minute. When slicing, automatic cross indexing takes place on the return stroke. Cross indexing can be set at the hydraulic control panel to produce slices of any desired thickness accurate to ± 0.0005-in. Slices are held for dicing by cementing them to ceramic plates held by a fixture on the work table. *DoAll Co., Des Plaines, Ill.*

Testing and Inspection

Vibration Machine: Model AF vibration machine with 10 to 60 cps adjustable frequency vibration is used in the electronic and instrument industries for vacuum tube and instrument stabilization or aging, accelerated life testing, production line inspection for vibration-induced noise and intermittent faults, and general vibration testing. It fulfills the fatigue test and low frequency vibration requirements of MIL-E-1B. The machine consists of an elastically-mounted platform, pickoff, forcing transducer and power amplifier. Self-perpetuating resonant drive principle provides long, uniform vibration life and high load capacity, since all motion is by means of flexing steel members. Maximum load is 70 lb; maximum amplitude, 0.1-in. Amplitude is controlled by a knob, and frequency is set by adjustable links on the supporting flex members. Power requirement is 100 w, 115 v, 60 cycles ac. *Lance Products, Forest Hills, N. Y.*



ALL EYES... You'll be this way at the NATIONAL PLASTICS EXPOSITION. New applications, new equipment, new materials. All on display at New York, June 11-15. Don't miss latest developments in your field. Send for tickets now. Please make request on your company letterhead. (Sorry, no general public admissions.)

Plastics shaping tomorrow's products

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7th National Plastics Exposition sponsored by:

The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, N. Y.

—ITEM 685—

FAST PUMPING WITH VIKINGS in EITHER *DIRECTION*

Tri-Par Oil Company, Saukville, Wisconsin, makes good use of Viking Pump's reversible feature. The pumping system has a single suction line and a single discharge line which can be operated in either direction, eliminating the piping manifold. Speeded to deliver 325 G.P.M. the pumps can unload transports to storage and load delivery trucks from storage by merely reversing action.

Pumping units have lost no time from their operation, during the three years they have been in service, and have handled approximately 25,000,000 gallons of gasoline and fuel oil in that period.

Perhaps Viking Pumps can speed your operation and simplify your pumping. Types and sizes for most industrial pumping. For information, write for Bulletin 56Sh.

VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A. In Canada, it's "*ROTO-KING*" pumps

See our catalog in Sweets

—ITEM 686—

NO MOTOR BURNOUTS

THIS MOTOR HAS INHERENT
KLIXON
OVERHEATING PROTECTION
B
G
Bell & Gossett Company

in Bell & Gossett Booster Pumps...

They are Protected with
KLIXON
Inherent Motor Protectors

Bell & Gossett, foremost manufacturer of quality, long life booster pumps, knows the value of KLIXON Inherent Overheat Motor Protectors . . . knows from experience how KLIXON Protectors guard against motor burnouts, and add to the dependability of the pumps.

Here's what the latest B&G Sales Bulletin has to say about KLIXON Protectors —

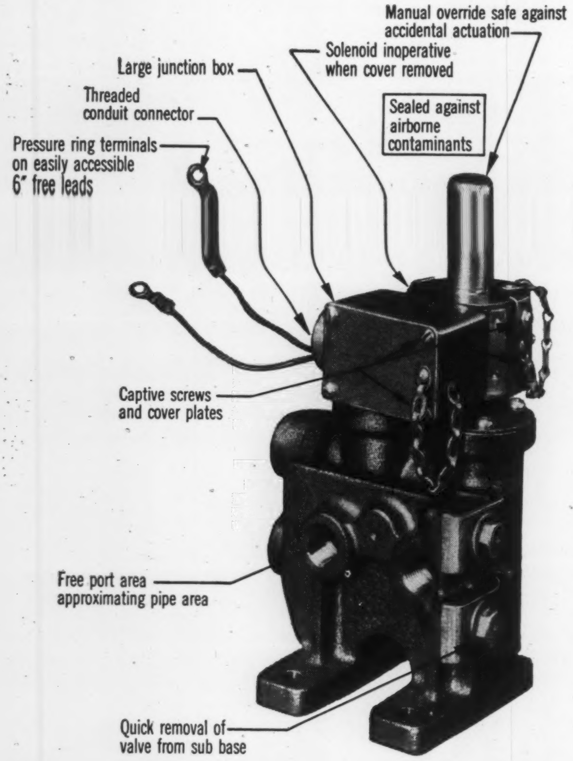
> **"PROTECTED AGAINST MOTOR BURN-OUT**
>
> The B&G Booster Motor is protected against both usual and unusual causes of failure. Modern, efficient thermal overload equipment shuts off the motor should a dead-stall be caused by foreign matter in the pump, or if low voltages should cause the motor to overheat.
>
> "If for any of the above reasons the motor should stop, it will automatically try to start after a short interval. It will continue to stop and start until the cause of the overload is removed. The operation of this protective device is not harmful to the motor."

You, too, can keep motor-driven equipment operating dependably by specifying and using KLIXON protected motors. They reduce maintenance costs, service calls, repairs and replacements. The additional cost is low . . . with exceptionally worthwhile benefits for everybody concerned.

KLIXON®

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
3205 FOREST STREET, ATTLEBORO, MASS.

—ITEM 687—
For More Information Circle Item Number on Yellow Card—page 19


Manual override safe against accidental actuation
Solenoid inoperative when cover removed
Large junction box
Threaded conduit connector
Sealed against airborne contaminants
Pressure ring terminals on easily accessible 6" free leads
Captive screws and cover plates
Free port area approximating pipe area
Quick removal of valve from sub base

For Machine Designers Who Want More Than Just 'JIC' Compliance, the Crescent® 4-Way Valve

®Product of Crescent Valve Company for the control of air, water and light oil to 150 P.S.I.

Pointed out on the photo above are the JIC features which are a must for many equipment manufacturers to gain acceptance of their machines in a growing number of production conscious plants. However, they offer obvious advantages even where they are not specifically demanded. Furthermore the JIC type Crescent solenoid is completely interchangeable with standard solenoids for the convenience of those manufacturers who want the JIC features available only for required application.

COMPETITIVE

With all its superior operating features the Crescent valve is probably the most competitively priced line on the market, particularly in the light of liberal trade and quantity discounts.

COMPACTNESS

Space, labor and materials savings have been pointed out to us by many equipment manufacturers as benefits from Crescent's compact design.

INTERCHANGEABILITY

Crescent valves can be converted to any practical current or voltage AC or DC by a simple coil change.

NO COIL BURNOUT

Short stroke, pilot operation and a generous power margin prevent overheating, overloading and the resultant coil burnout.

Write for Catalog 6-C

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

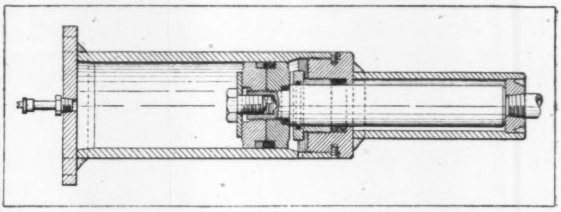
—ITEM 688—

NOTEWORTHY

Patents

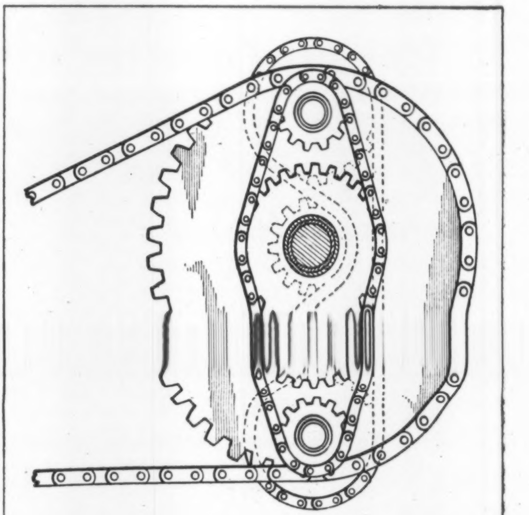
Hydraulic Flow Damper

Sudden pressure variations in hydraulic systems are smoothed by an absorber consisting of two coaxial cylinders. Position of the inner cylinder is a function of the pressure in the system. Compressed air in the outer cylinder opposes movement of the inner cylinder. Varying the air pressure changes the sensitivity and response of the inner cylinder to pressure shocks in the system. *Patent* 2,714,899 *assigned to Commercial Shearing and Stamping Co. by T. C. Kane.*



Differential Chain Drive

Unequal division of torque transmitted from a single power source is accomplished by a series of chain-driven sprockets. Two sets of "planetary" pinion sprockets, mounted on opposite sides of a large "carrier" sprocket, drive corresponding "sun" sprockets fixed to separate output shafts through independent link chains. Ratio of the diameters of the two sets of planetary pinion sprockets determines the amount of



Simple Arithmetic...

Type **302**, Sheet Base Price **44.50** cents per lb.

Type **430**, Sheet Base Price **-34.50** cents per lb.

Saving **10.00** cents per lb.

in Stainless SHEET Costs!

Now You Can SAVE $200 Per Ton!

Many designers and fabricators who are currently using Type 302 stainless can, in numerous applications, specify Type 430 straight chromium stainless and take advantage of the 10 cents per pound difference in base price. Some of our customers are already saving more than $200 per ton using our 430 MicroRold stainless sheet.

The steel industry estimates that 50% of all stainless sheet applications could satisfactorily employ Type 430, the least expensive of all stainless grades, as an economical and practical material. When properly applied, Type 430 has all the desirable qualities of beauty, corrosion resistance, strength, long life and low maintenance that no other material, except stainless, can offer.

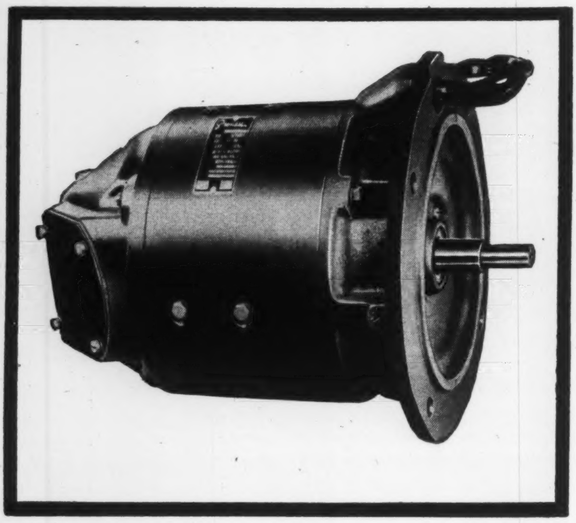
We are currently producing our MicroRold Type 430 sheets in thicknesses .005″ to .109″ with 2B or 2D finishes; and in thicknesses .010″ to .109″ in No. 3, 4 and 7 finishes.

Send for Your copy, "Care and Use of 430 MicroRold Stainless Steel"

Washington Steel *Corporation*

5-E WOODLAND AVENUE, WASHINGTON, PA.

Direct Current
TORQUE MOTOR
PRECISELY POSITIONS
HEAVY DIES



This Peerless direct current torque motor was designed specifically for one of our customers. It operates through a gear unit to smoothly position heavy dies on die-making machinery. An adjustable brush mechanism and rugged construction permit the design to be extremely sensitive and accurate — a necessity for precision die alignment. The motor pictured is one of many DC torque motor designs available at Peerless in the 1/2–3 HP range.

Peerless-customer teamwork made this motor possible. We can apply our motor knowledge to your application in the same way. Let us check your "specs" and give our recommendations. We'll help you select the one motor that powers your product best.

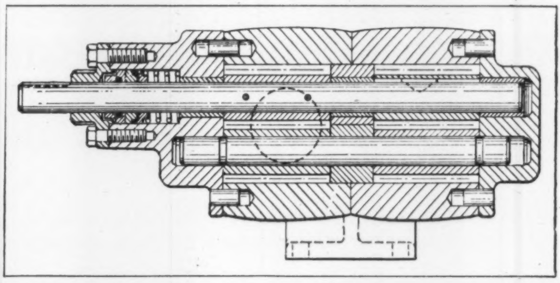
ELECTRIC MOTOR DIVISION
THE Peerless-Electric® COMPANY
FANS · BLOWERS · ELECTRIC MOTORS · ELECTRONIC EQUIPMENT
1520 W. Market St., WARREN, OHIO

—TEM 690—
For More Information Circle Item Number on Yellow Card—page 19

torque transmitted to each output shaft. *Patent* 2,716,358 *assigned to International Harvester Co. by S. D. Pool and W. H. Walker.*

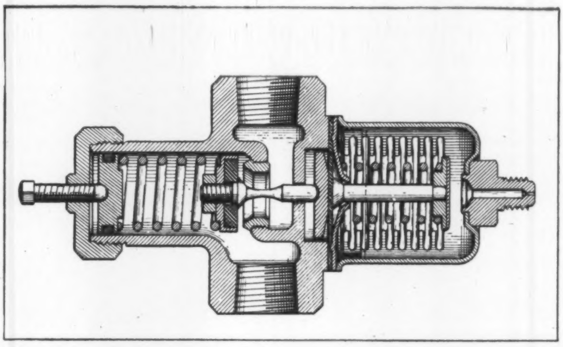
Noiseless Gear Pump

Gears of substantially greater length than their diameters are employed in a pump to obtain a relatively smooth, noiseless pumping action. Alignment is simplified by providing intermediate, rather than end, bearings to support the gears. End plates are thus eliminated by this type of assembly. *Patent* 2,714,857 *assigned to Geo. D. Roper Corp. by J. R. Albright and S. E. Larson.*



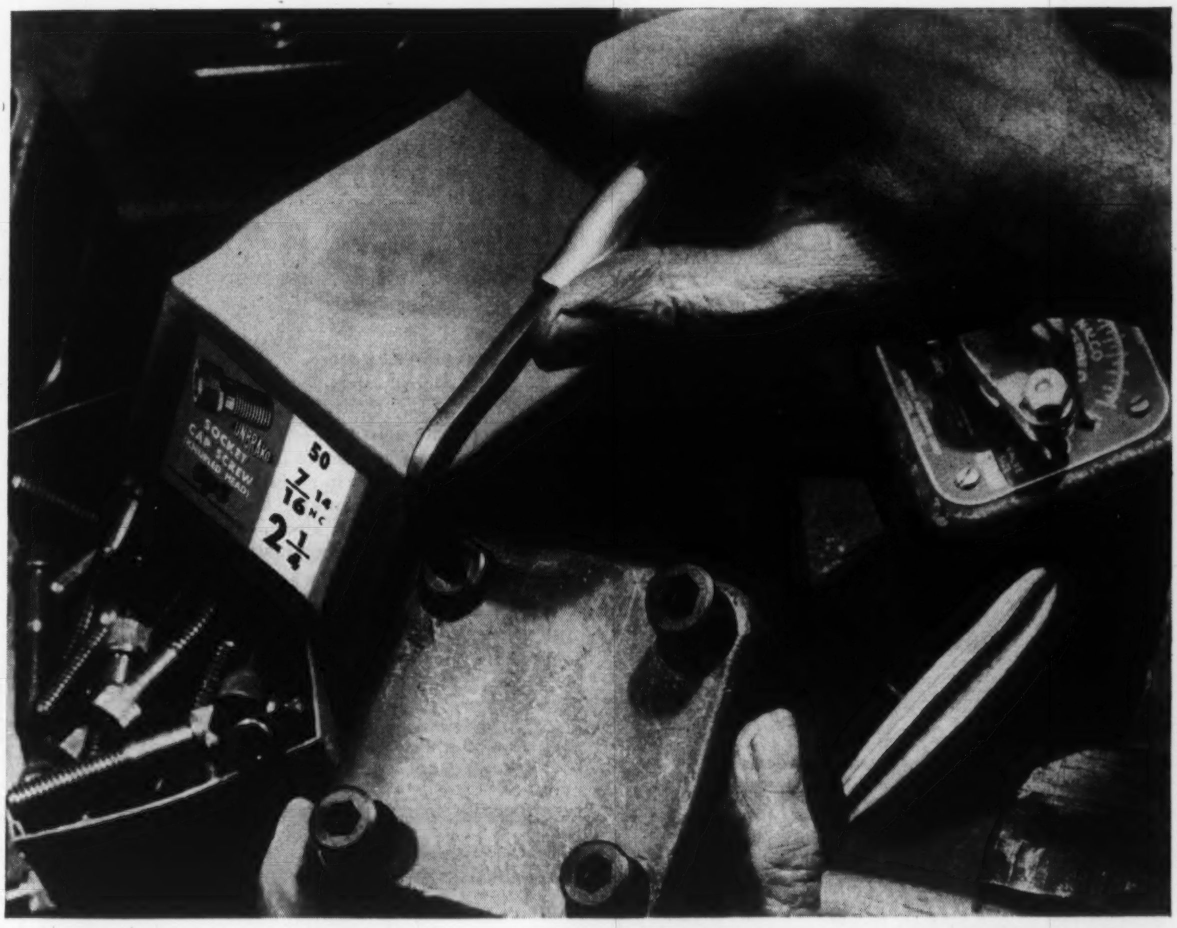
Air-Operated Valve

Increased air or fluid pressure within an enclosed chamber actuates a bellows, which, by means of a push rod, operates a hydraulic valve. A helical spring holds the valve normally closed. A second spring maintains alignment of the push rod. Area of surfaces in frictional contact between the moving parts of the assembly is held to a minimum, reducing operating force requirements. *Patent* 2,715,009 *assigned to Electrimatic Co. by H. L. Beekley.*

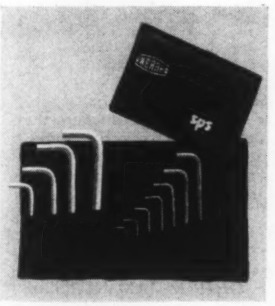


Bearing and seal assembly utilizes grease as a packing to intercept dirt and other foreign material before it reaches the bearing. *Patent* 2,715,554 *assigned to Allis-Chalmers Mfg. Co. by M. E. Walberg*

Copies of patents briefed in this department may be obtained for 25 cents each from The Commissioner of Patents, Washington 25, D. C.



Tighten socket screws tighter, more safely with High-Titan UNBRAKO hex keys

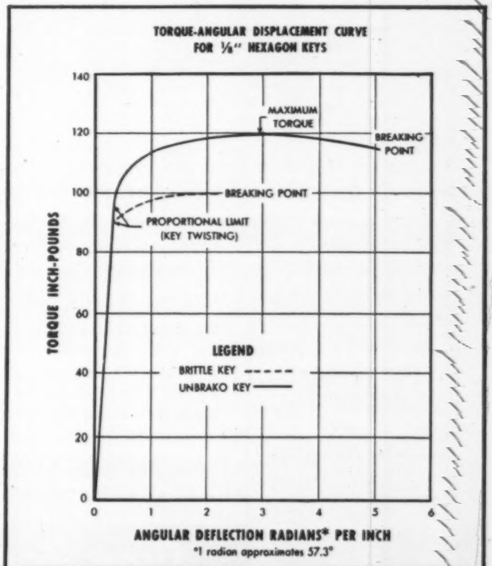


High-Titan Unbrako socket screw keys are stronger than ordinary keys. They are made of selected, accurately sized hex stock, with carefully formed 90° bends that won't break. The ends are cut square to engage sockets full depth for highest tightening power. These keys are heat treated uniformly to give hardness and ductility clear through without brittleness or decarburization.

All this results in many advantages. You can torque up a screw tighter with an Unbrako than any other key. Performance is consistent—you can apply the same tightening torque every time. Screw sockets won't ream, and the keys won't wear excessively. If you should apply too much torque, a High-Titan would break, but shear off clean and even with the top of the socket—not at the bend—and without leaving jagged exposed edges to gash your hands.

One High-Titan hex key is included with each standard package of Unbrako socket screws. High-Titans are also available as sets in convenient, durable plastic key folds, and in bulk. Your authorized industrial distributor carries them in stock. See him today. Unbrako Socket Screw Division, Standard Pressed Steel Co., Jenkintown 18, Pa.

See us at the Design Engineering Show
Booth 333-335

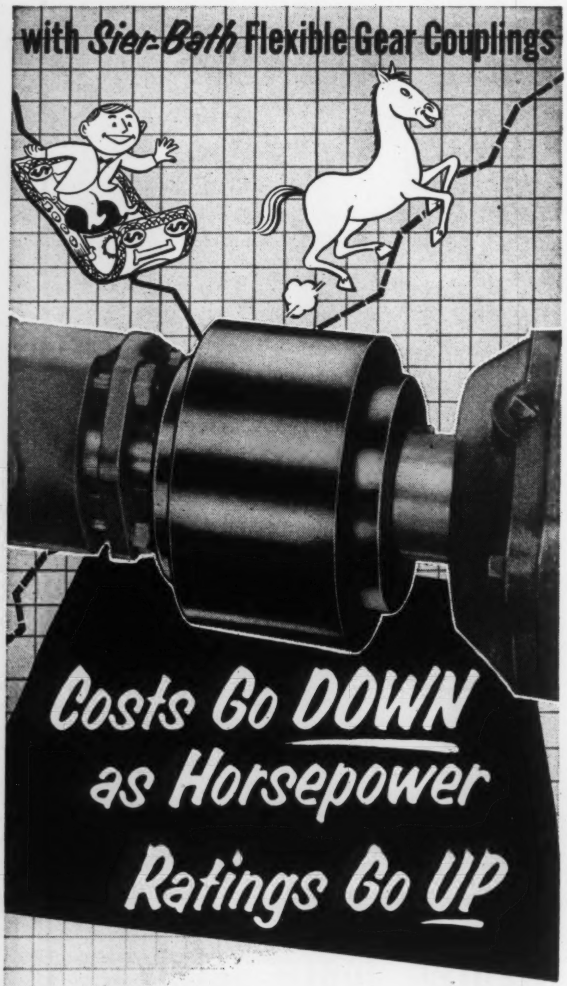


These curves show the difference between an Unbrako hex key and an ordinary key. The Unbrako withstands more tightening torque, twists through 180° without breaking, then shears off even with the top of the screw socket. Ordinary keys snap off suddenly at the bend.

UNBRAKO ® **SOCKET SCREW DIVISION**

STANDARD PRESSED STEEL CO.
SPS
JENKINTOWN PENNSYLVANIA

—ITEM 691—
For More Information Circle Item Number on Yellow Card—page 19

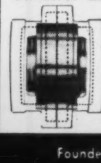


Where horsepower loads are heaviest . . . that's where Sier-Bath Flexible Couplings are stand-outs in performance and economy! Not only are Sier-Bath Coupling capacities higher for any given shaft size from 3" to 12", but also their *initial cost to you averages 21-percent lower* (compared to four other leading brands).

You save many ways with Sier-Bath Couplings, because simplicity of design makes possible great savings in space and weight, requiring *less* shaft space for assembly . . . and use of snap-rings instead of flanges and bolts cuts assembling and uncoupling time to seconds, eliminating special tools. Lower moment of inertia reduces bending stresses on shafts, saves bearing wear.

Simpler! only 7 parts

Smaller and Lighter!



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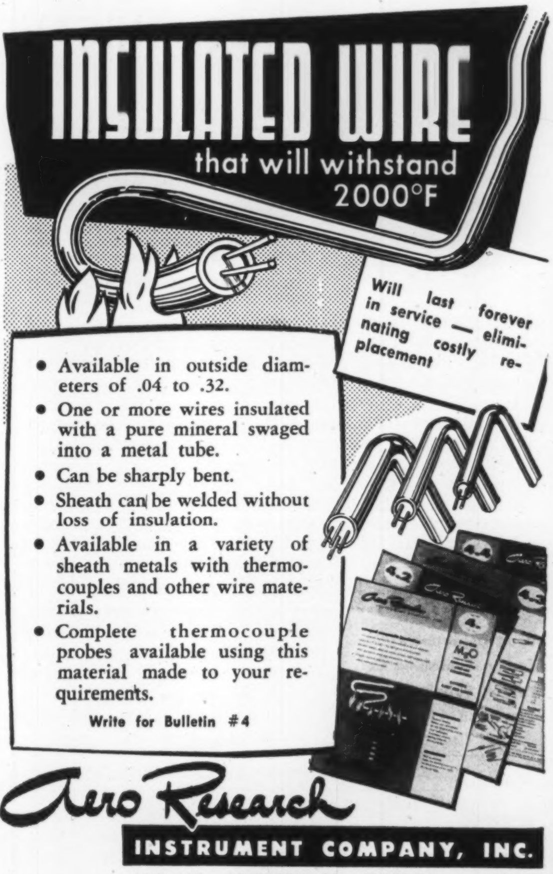
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Corning means research in Glass

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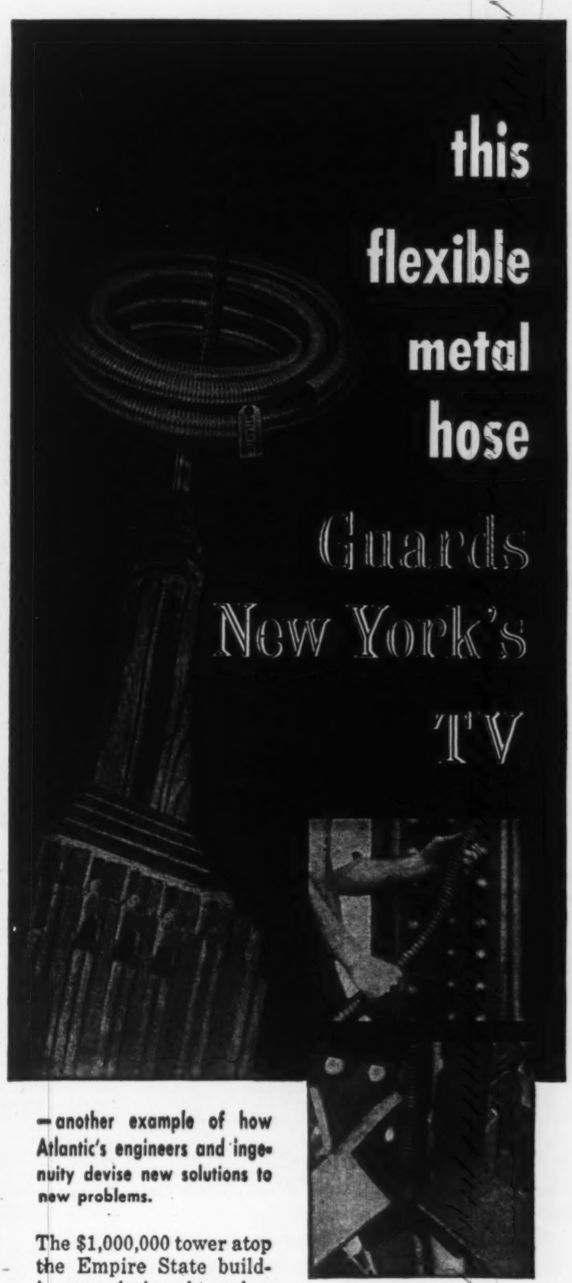

—another example of how Atlantic's engineers and ingenuity devise new solutions to new problems.

The $1,000,000 tower atop the Empire State building was designed to usher in a new era in TV transmission and reception. Its construction required an unprecedented number of circuits to travel up a tower often of less than two feet square. The conduit, enclosing the cables, had to be extremely *flexible* to avoid splice plates, rivet heads and diagonal braces in the steel work. It had to be permanently weather tight.

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—ITEM 700—

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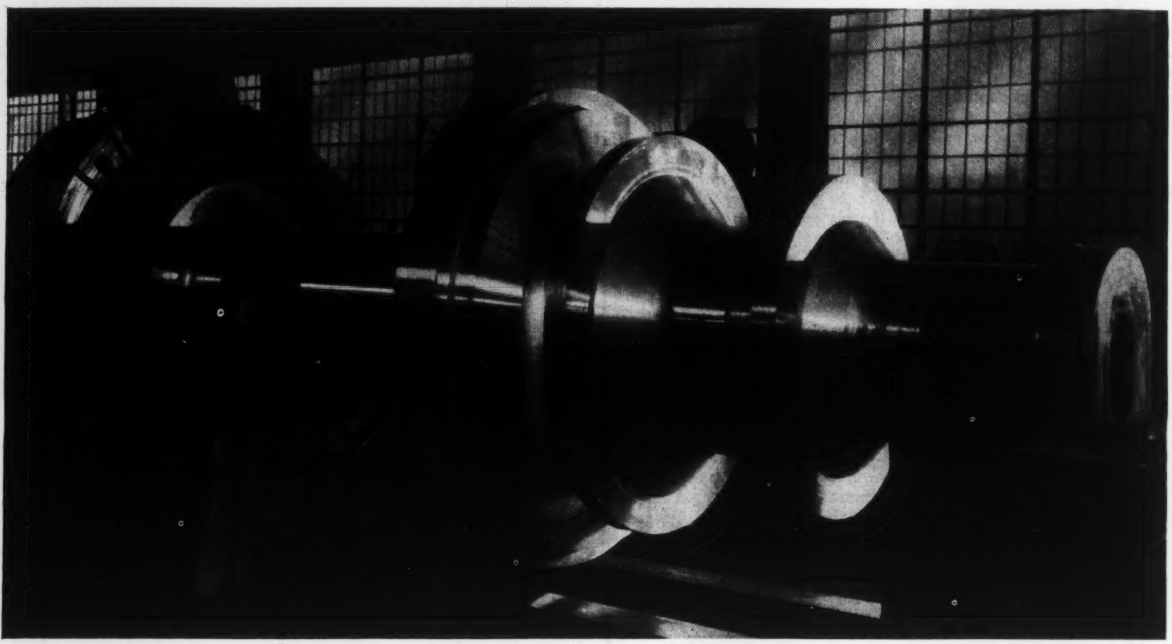

Here are two giants of steel that were recently created in the Bethlehem shops. Though dissimilar in shape and dimensions, their basic business is the same—to help make power for the country's growing needs.

That big shaft will do an important job in a Western hydroelectric project. A forging made of carbon-vanadium steel, it weighs approximately 61 tons. Its overall length exceeds 22 ft.

The vaned runner in the other illustration is a foundry product. Like the forging, it's a whopper, weighing 49 tons. It too is earmarked for a hydroelectric installation.

Through the years Bethlehem has furnished many large components for use in power production. Countless Bethlehem forgings and castings are also in service in other industries. Some of these pieces are huge—but please remember, we're equally well equipped to turn out small items, too. For instance, some of the drop forgings we make are small enough to tuck into your vest pocket.

When your needs call for either forgings or castings, we hope you'll get in touch with us. Whether your order runs to tonnage or is small, we'll give it all we've got!

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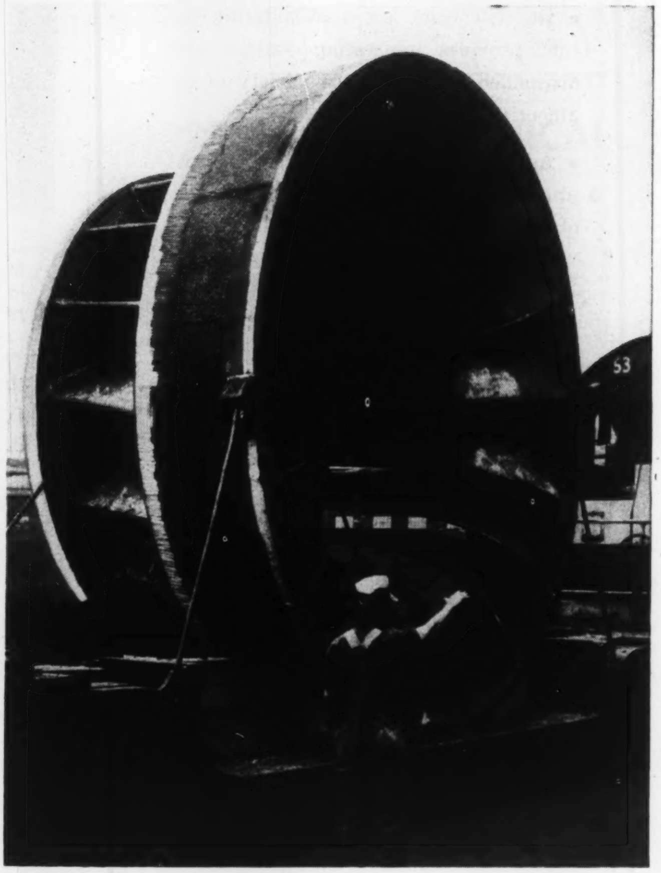

BETHLEHEM STEEL

BETHLEHEM STEEL

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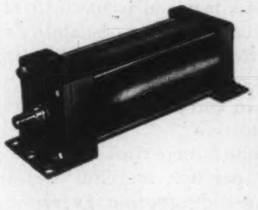

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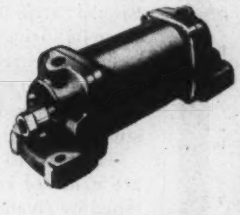
150 P.S.I. air; 250, 350, 500 P.S.I. oil. 8 mountings; 10 bore diameters; single or double end rod; internal or external thread; cushioning. J.I.C. Special covers. See Catalog 10.



KEEPER RING DESIGN

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Panel Mounted Solenoid

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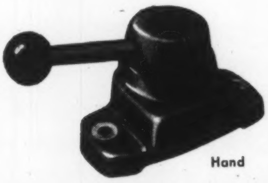
Greater flow; low pressure; shock resistant. Interchangeable sizes. See Catalog 261.

AIR VALVES—47 Models



Hand

150 P.S.I. 3 and 4-way. Hand, foot, cam, solenoid, and pilot. ¼", ⅜", ½", ¾" and 1". Pilot valves in side and foot mountings—palm, push-button, cam, foot, solenoid operation. See Catalog 303.

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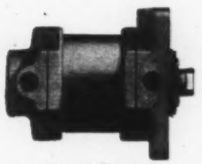

Keeper Ring

300 and 1500 P.S.I.; 3000 P.S.I. furnished. 7 mountings; 10 bore diameters; standard and 2:1 over-size rod: single and double end rods, internal or external thread; cushioning. Special covers. See Catalog 106.

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—ITEM 703—
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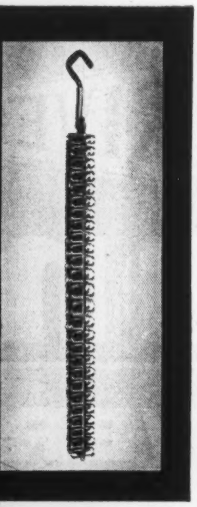
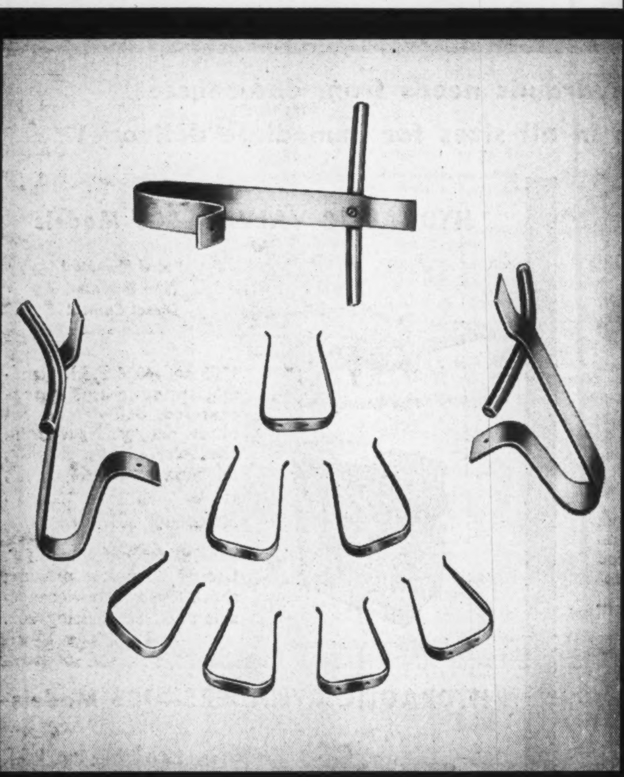
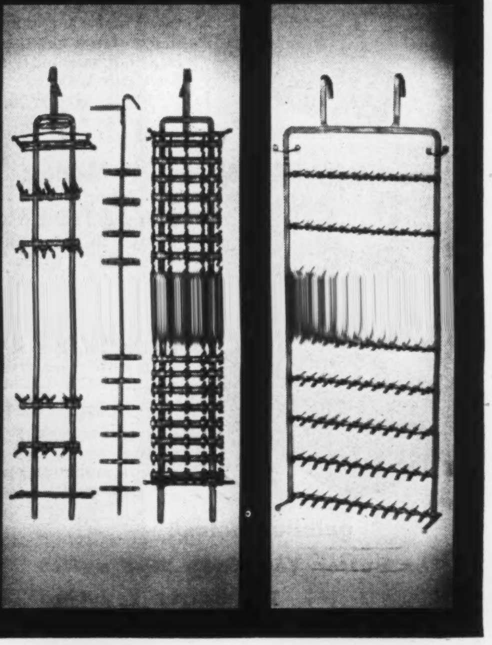




When small parts have to be plated, the problem arises as to how to hold them on the plating racks. If they are not heavy enough to hang by their own weight, spring clips must be used. For such clips, the Higgins Rack Coating Mfg. Co., Hazel Park, Mich., uses spring temper Revere Phosphor Bronze Strip. This material is specified because its spring temper gives it the ability to withstand repeated flexing, so that the clips can be used repeatedly, and that small parts can be snapped in and out of them quickly and without distortion.

The racks to which these clips are attached are made of copper bar; the clips are fastened by riveting and soldering. Everything except the contact points of the clips is coated to prevent deposition of the plating metal and loss of current. Higgins is an important supplier of these special racks to the automotive industry, which uses them to plate both interior and exterior trim. The efficiency and economy of this method helps make handsomer cars and trucks as well as numerous other attractive consumer commodities.



Clips and racks made to special designs by the Higgins Rack Coating Mfg. Co., which buys Revere Phosphor Bronze Strip for the clips from Copper and Brass Sales, Inc., a Revere Distributor in Detroit, Mich.

REVERE

COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N.Y.
Sales Offices in Principal Cities, Distributors Everywhere.

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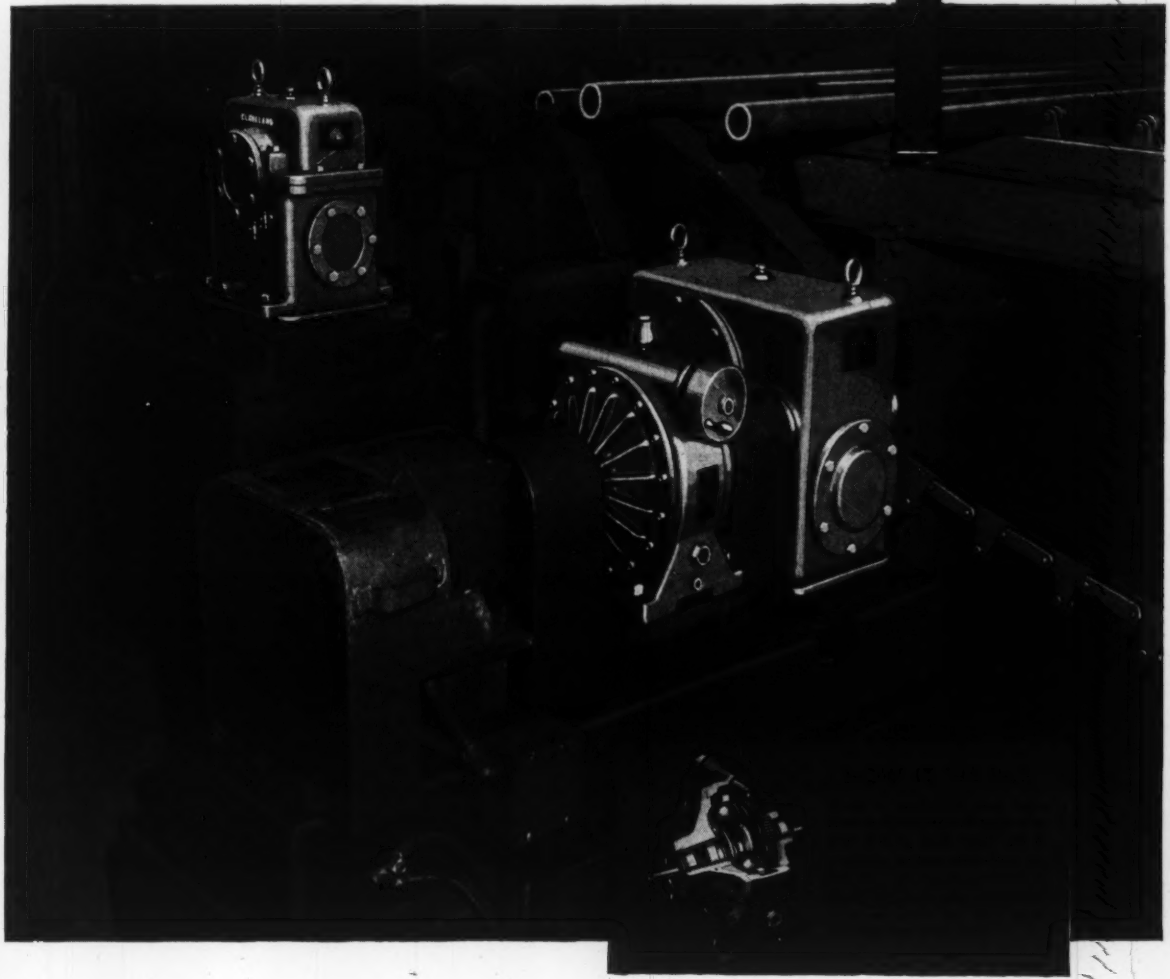
For More Information Circle Item Number on Yellow Card—page 19

Hot pipe conveyor travels at precision pace set by CLEVELAND Speed Variator

Drag-type conveyors utilizing Cleveland Speed Variator Size 6K4 Series 1. Driving Cleveland Double Reduction Worm Gear Size 051D Series F, ratio 900:1.



THIS hot pipe conveyor produced by York-Gillespie Mfg. Co. is a good example of the precision engineering applied in steel mill operation today. Conveyor speed has to coincide exactly with the speed of other operations on the line—has to adjust to the pace of production anywhere in the line. That's why a Cleveland Speed Variator is on the job!

Being infinitely variable, the Speed Variator gives stepless speeds over its full 9:1 range—from ⅓ to 3 times input speed. Output speed is adjusted manually by a hand wheel mounted on the Variator—but could be regulated automatically by remote controls of various types.

The Cleveland Speed Variator provides these major advantages: 1. An extremely compact unit with input and output shafts in line and rotating in the same direction; 2. Almost any input speed up to 1800 rpm can be used—either clockwise or counterclockwise rotation; 3. Rated for constant horsepower output over a 9:1 range, or for constant output torque with a 6:1 range; 4. Infinitely variable over the entire speed range; 5. Rapid response to speed change, precise adjustment, and accurate maintenance of speed settings; 6. Long life and minimum maintenance due to absence of belts or complicated linkages; 7. Ample bearing support for overhung pulleys on either input or output shafts.

This revolutionary variable speed drive is available in eighteen standard types and sizes. For detailed description of the Cleveland Speed Variator with photographs, sectional drawings, rating tables and specifications, write for Bulletin K-200.

THE CLEVELAND WORM AND GEAR COMPANY

Speed Variator Division, 3287 East 80th St., Cleveland 4, Ohio

Sales representatives in all major industrial markets. In Canada—Peacock Brothers Limited.

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For More Information Circle Item Number on Yellow Card—page 19